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A TRACE CONTAMINANT ANALYSIS TEST ON AIR SAMPLES

F. G. Sherrell and J. A. Baltz
ARO, Inc.

March 1966

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AEDC-TR-66-42, March 1966

A TRACE CONTAMINANT ANALYSIS TEST ON AIR SAMPLES

F G Sherrell and J A Baltz, ARO, Inc.

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A TRACE CONTAMINANT ANALYSIS TEST
ON AIR SAMPLES

F. G. Sherrell and J. A. Baltz
ARO, Inc.

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FOREWORD

The work reported herein was done at the request of the USAF School of Aerospace Medicine, Aerospace Medical Division, Air Force Systems Command (AFSC), Brooks Air Force Base, Texas. The work was done under Program Element 62405154, Project 7930; James P. Conkle was the project monitor.

The test described herein was conducted by ARO, Inc. (a subsidiary of Sverdrup and Parcel, Inc.), contract operator of the Arnold Engineering Development Center (AEDC), AFSC, Arnold Air Force Station, Tennessee, under Contract AF 40(600)-1200. The test was conducted under ARO Project No. ST0518, and the activities directly associated with the test extended from April 12 until October 7, 1965. The manuscript was submitted by the authors on February 2, 1966.

The instruments used during this test were commercial instruments that were not necessarily developed or manufactured either to meet Government specifications or to operate as applied during this test. Any failure to realize test objectives is no reflection on the instruments or on any manufacturer.

The data as reported is raw data. Final determination of contaminant concentrations will be made by the sponsor using information from this report and two other independent parallel analyses done by other organizations.

This technical report has been reviewed and is approved.

William D. Clement
Major, USAF
AF Representative, AEF
DCS/Test

Jean A. Jack
Colonel, USAF
DCS/Test

ABSTRACT

A test in which wet air samples were analyzed for trace contaminants was conducted at the Arnold Engineering Development Center for the USAF School of Aerospace Medicine. Sample processing and analysis techniques used during the test are described. The sample processing technique provided a way to transfer the 77°K condensables in each sample to a trap of a small volume. This trap was designed to allow removal of small portions of both the sample vapor and the liquid for mass spectrometric and chromatographic analyses. The chromatographic and mass spectrometer instrumentation, calibrations, and data reduction procedures are described. The basic test results are presented and discussed. Observations are made concerning the utility of the procedures used.

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SECTION I INTRODUCTION

The gaseous test samples received from the USAF School of Aerospace Medicine (SAM) were cryogenically trapped from the atmosphere of a sealed, spacecraft cabin simulator. The trapping procedure employed by SAM consisted of continuously circulating air from the simulator through a set of three 150-cc stainless steel sample bottles shown in Fig. 1. The three bottles were connected in series and maintained at 0, -78, and -175°C, respectively. After a 10-hr trapping period, the three bottles were valved off, removed from the simulator, packed in dry ice, and shipped to the AEDC for content analyses. A sample set was collected and shipped each day for 27 consecutive days.

The 27 sets were collected during a test conducted by SAM to study contaminants of the life-supporting atmosphere in the spacecraft cabin simulator. Two days after the start of the test, the air purifier on the simulator was activated, and during the last 14 days of the test, the simulator was occupied by four men. These activities were reflected in the amounts of CO₂ and trace contaminants found in the samples.

The samples consisted of wet air and small quantities of hydrocarbon and chlorinated trace contaminants. Those samples trapped at -78 and -175°C were also enriched with CO₂. The basic test requirement of AEDC was to identify and determine the total mass of each trace contaminant contained in each sample bottle. The quantities of CO₂ were also required. These requirements generated three specific test objectives: (1) Establish a sample processing procedure which was compatible with the type of sample and with the types of available analytical instruments, (2) Calibrate the analytical instruments and establish data reduction procedures, (3) Qualitatively and quantitatively analyze the 27 sets of SAM samples.

SECTION II ANALYTICAL APPARATUS

The available analytical instrumentation included a chromatograph, a time-of-flight mass spectrometer, and an infrared spectrophotometer. Analyses of preliminary trial samples supplied by SAM indicated that the concentrations of the trace contaminants were too low to be measured on the spectrophotometer. Therefore, the sample processing and analytical procedures were directed toward the use of the chromatograph and the mass spectrometer.

2.1 SAMPLE PROCESSING APPARATUS

An important consideration in the design of a sample processing apparatus was that the SAM samples contained enough water to form liquid at room temperature. Many of the trace contaminants were highly soluble in water and others were insoluble. Since no technique was available for removing the water without the probability of removing trace contaminants, it was necessary to analyze both the vapor and the liquid in each SAM sample. Because there were no provisions for withdrawing portions of the liquids from the SAM sample bottles, the contents of each bottle had to be transferred to another sample trap. This sample trap was designed to permit withdrawal of portions of both the liquid and the vapor for analysis.

The sample transfer was accomplished by evacuating the SAM sample bottles through 78°K (LN₂ temperature) sample traps. This procedure was assumed to result in no significant loss of trace contaminants because: (1) The lowest temperature at which the SAM samples were originally trapped was 98°K (-175°C), whereas the vapor pressures of all trace contaminants likely to be in the samples drop sharply (one to three decades depending on the material) when cooled from 98 to 78°K, (2) All samples contained bulk water and/or CO₂ which contributed to the trapping of trace contaminants. The quantity of air in each sample was not required and loss of N₂, O₂, and argon during evacuation could be tolerated.

The sample processing apparatus used in the transfer of the LN₂ temperature condensables from each SAM sample bottle to the sample trap is shown by line diagram in Fig. 2. Except for the SAM sample bottle and the valves on the sample trap, the system was all glass. The Type I sample trap, shown in Fig. 3, was used during the processing of the first seven sample sets. Three traps of this type were fabricated so that the analysis of one sample could proceed while the other two samples in a set were processed. The mass of each trap was approximately 480 gm and was determined to within 10 mg. The trap volumes were approximately 120 cc as determined using the calibrated buret and manometer shown in Fig. 2.

Two days after the test started, the water and CO₂ content of the samples dropped. Because of this and other reasons which will become apparent in Section IV, the need developed for less massive and lower volume sample traps. Thus, the Type 2 traps shown in Fig. 4 were used during the processing of the last 20 sample sets. Approximately 60 of the Type 2 were fabricated. These traps were not equipped with valves, but the sidearms of the trap were fused directly into the system at the location indicated for the sample trap in Fig. 2. Figure 4 shows, from left to

right, a new trap prior to use, a trap containing a sample ready for analysis (notice the liquid), and a trap after analysis. The center tube of each trap was 0.5 in. OD by 8 in. long and contained a break seal near its middle. The volumes of the traps were approximately 16 cc and were determined prior to use by weighing each trap when empty and when filled with water up to the necks on the sidearms.

The mercury diffusion pump and its associated forepump (Fig. 2) were used to evacuate the SAM sample bottle via the sample trap. The transducer was used to give a rough indication of the system pressure. When using the Type 1 sample traps, the final trap pressure was measured with the manometer. The buret was used to keep the final trap pressure within the range of the manometer.

Both types of sample traps (Figs. 3 and 4) were equipped with rubber septums through which portions of liquid or vapor were withdrawn using syringes. Each portion was then injected into the chromatograph for analysis. Portions of liquid were withdrawn in the same way for analysis on the mass spectrometer. The trap vapors were analyzed on the mass spectrometer by temporarily installing each sample trap on the mass spectrometer gas inlet system which is described later. Detailed descriptions of the sample processing and analytical procedures are presented in Section IV.

2.2 CHROMATOGRAPH

The chromatograph used was the F & M Scientific Corporation Model 720, linear programmed gas chromatograph equipped with a Model 1609 flame ionization detector. The basic components of the gas chromatograph are shown schematically in Fig. 5. The retention column consisted of 0.25-in. -OD tubing, 10 ft long, which was packed with 10-percent silicone rubber on Chromosorb.

To establish column operating conditions which would yield reasonable separation of expected diverse compound types, trial runs of various mixtures were made. The conditions established and used for all analyses were: injection port temperature, 238°C, injection block temperature, 220°C; flow rate of helium carrier gas, 250 cc/min; flow rate of hydrogen, 40 cc/min, flow rate of air, 310 cc/min; column temperature program, ambient to 125°C at 5°C/min, electrometer range, 10, chart speed, 3 in./min, optimum sample sizes, 2.5-cc gas, 10- μ l liquid.

Operation of the chromatograph is as follows: The sample is injected by syringe through the injection port, a silicone rubber septum. The

sample vaporizes and is swept by the helium gas into the retention column. The various components in the sample have different affinities toward the column packing, and they separate into discrete moving bands as they are flushed through the column by the helium. At the exit of the column, hydrogen is introduced into the gas stream which then passes on to be burned in the flame. Ions generated as each component in the sample is consumed in the flame are collected on the ion collector loop which is biased at -130 v. The ion current is amplified by the electrometer and displayed on the chart recorder. The number of ions generated from each component is directly proportional to the amount of that component in the sample. However, the sensitivity varies with the type of compound, and individual calibrations are necessary.

The temperature of the retention column is programmed to increase from ambient to 125°C at 5°C/min while the sample is flushed through the column. This programming feature allows components with a very strong affinity for the column packing to elute in a reasonable length of time.

Each compound has a characteristic column retention time which is determined by calibration. For example, acetone is swept through the column in approximately 2.8 min. The retention ratio of a compound is defined as the ratio of the retention time of the compound to the retention time of acetone. Retention ratios of compounds encountered in the test are reported in Section 3.1. A photograph of the instrument is shown in Fig. 6.

2.3 MASS SPECTROMETER

The mass spectrometer and its associated vacuum system are shown in Figs. 7 and 8. The mass spectrometer, a Bendix Model 17-210V, is a time-of-flight instrument with unit resolution to approximately 200 amu. The principles of operation of the vacuum system (Fig. 7) are described in Ref. 1. Briefly, the principles are as follows. The test region pressure, P_2 , is related to the leak conductance, C_1 , the pumping speed, S_r , and the leak forepressure, P_1 , by:

$$P_2 = \frac{C_1}{S_r} P_1 \quad (1)$$

The pumping speed, S_r , is calculated from $S_{r_i} = (60.4 \pm 2 \text{ percent}) (28/M)^{1/2} \text{ l/sec}$ for each gas of molecular weight M . The leak conductance, C_1 , is determined experimentally for each type of gas, and P_1 is measured using the pressure meter. The ratio C_1/S_r , the calibration constant, varies slightly with molecular weight and must be determined

for each type of gas. Equation (1) was applied during the calibrations of the mass spectrometer. Calibration data are presented in Section 3.2. Equation (1) was also used in the form

$$P_1 - \frac{\gamma_r}{C_1} P_2 = kP_2 \quad (2)$$

while reducing the data from the SAM sample analyses. The data reduction procedure is described in Section 4.3.

As noted in Fig. 7, the vacuum system has three separate gas inlet systems, each of which is equipped with a porous stainless steel molecular leak. Two of these systems were used during the present work. One system was used to standardize the mass spectrometer prior to each day's work. Using this inlet system, a P_2 of $1 \cdot 10^{-5}$ torr of pure N_2 was established, and the sensitivity of the 17-210V was checked. If the sensitivity had changed, the multiplier gain was adjusted to give a sensitivity of $1 \cdot 10^{-3}$ amp/torr with the mass spectrometer manually adjusted to the mass 28 peak. The sensitivity usually did not change by more than ± 5 percent from day to day.

The second gas inlet system was used during analyses of the SAM samples. For the liquid analyses, the vacuum regulator (Fig. 7) was removed and a 1-liter (ℓ) glass bottle was installed on the input bleed valve. The bottle was equipped with a rubber septum of the type shown on the sample traps (Figs. 3 and 4). After the bottle had been pumped to about 2 microns (μ) through the two bleed valves, the input bleed valve was closed and a 100- $\mu\ell$ portion of the liquid sample was injected through the septum. The sample promptly evaporated. During the mass spectrum scan, the bleed valve in the pumpout line was closed, and the input bleed valve was adjusted so that the leak forepressure (the pressure P_1 in the surge volume) remained constant. Usually P_1 was set at 100 μ .

During analyses of trap vapors, each of the sample traps was installed on the input bleed valve in place of the 1- ℓ bottle. The air was pumped out down to the valve on the Type 1 trap (or to the break seal in the Type 2 trap), and the input bleed valve was closed. The sample trap valve was opened (or the break seal was broken), and during the mass spectrum scan, the vapors were bled into the surge volume to maintain P_1 constant in the same manner as described above for the liquid analyses.

The break seal in each Type 2 trap was broken with a piece of glass encapsulated steel which was placed in the center tube of the trap and manipulated from the outside with a magnet.

SECTION III

CHROMATOGRAPH AND MASS SPECTROMETER CALIBRATIONS

3.1 CHROMATOGRAPH CALIBRATIONS

A series of standard mixtures containing compounds to be expected in the SAM samples was prepared. In the case of liquids, water or acetone was used as the solvent matrix. Other mixtures prepared by weighing pure compounds to produce 8 to 10 component standards were also used. Gases were run individually. As unknown compounds were detected and identified during the test, they were added to the appropriate standard solution for calibration purposes. Typical mixes used during the calibration effort are listed in Table I.

Standard mixes were prepared either by volumetric addition and conversion to weight or by direct weighing on a semimicro balance. Concentrations were adjusted to approximate the component concentrations expected in the SAM samples. All mixtures with water were prepared to contain 0.001 mg of each component per 10 μ l of solution (e.g. mixes 1, 2, and 3, Table I). Calibration mixes of pure compounds, such as Mix 4, Table I, were used at the 1- μ l sample size with the weight of each individual component being calculated from the number of components present and the original weight of each added to the mix.

The standard mixes were used under the established experimental conditions to obtain the column retention data and instrument response factor for each compound. The mixes were not only chromatographed individually but various combinations of mixes were run to further establish retention data and sensitivity. Acetone was included in all calibration mixes and was used to establish the base reference for the reported retention data. A master chromatogram, shown in Fig. 9, was synthesized for use in identifying peaks on the SAM sample chromatograms. This master was prepared from experimental trials of mixes and combinations of mixes and was assembled to best fit the data produced in analyses of the samples. The synthesis of this chromatogram was necessary, since various combinations of compounds produced slightly different retention data when chromatographed in mixtures of 2 to 6 or mixtures of 10 to 15 components. For example, the presence of many nonpolar or chlorinated compounds in the samples tended to compress the retention times of the lower boiling polar compounds in the first part of the chromatogram. This compressing effect in this part of the chart is clearly illustrated in Fig. 9 by the nonresolution of the ether-ethanol peak. These two compounds were resolved in other chromatograms which were run on a mixture of samples taken from

Mix No. 1 and No. 2, Table I. In areas on the chromatogram beyond retention ratio 1.65, the problem of slight changes in retention data with respect to composition for various mixtures were of little consequence. It appeared that this particular column packing was functioning both as a boiling point elution column and as a retention column.

In addition to the master chromatogram, several less complex chromatograms were prepared to aid in identification in various localized areas of the chart. The toluene peak occurring at retention ratio 3.95 consistently occurred at 95°C in the temperature programming cycle and was useful in chart orientation. Also, on the chromatograms of the liquids, there was a characteristic drop in the base line trace caused by the expulsion of water vapor at 62 to 64°C in the temperature programming cycle. This drop provided another reference point for retention calculations. During both the calibration work and the SAM sample analyses, acetaldehyde and methanol produced characteristic peak shapes which were also useful in chart orientation. Methanol gave the sharpest peak of all compounds investigated.

All retention data and sensitivities were established from the liquid phase except those of the five gases listed in Table II. Using the ideal gas relationship to calculate the mass, a known amount of each gas was injected into the chromatograph by syringe. The retention data for each gas was then calculated using the elapsed time from injection to detection, and the sensitivity was calculated as the ratio of the mass injected to the resulting peak height. Table II lists retention ratios and sensitivities for all compounds identified and reported in the SAM sample analyses. The sensitivity factors, S , were calculated from the following expression:

$$S = \frac{\text{Wt. of compound injected (mg} \times 10^{-3})}{\text{Peak height (or area)}} = \frac{\text{mg} \times 10^{-3}}{\text{division}} \quad (3)$$

Peak areas were measured only for a few compounds which produced broad peaks. When required in this calculation, the peak area was calculated by standard methods such as multiplying the peak height by the peak width at half height for symmetrical peaks or by multiplying the peak height by the retention time for peaks with leading or trailing edges. When incomplete separation occurred, the peak areas were determined as above except that the measurements were made with respect to artificial base lines generated by drawing freehand the base line-peak trace of each interfering peak. Peak height measurements of interfering peaks were also made with respect to such a base.

3.2 MASS SPECTROMETER CALIBRATIONS

In preparation for reducing the mass spectrometer data on the SAM samples, the molecular leak in one of the gas inlet systems and the mass spectrometer were calibrated using 41 pure gases and vapors. The molecular leak calibration procedure is described in Ref. 1. Equation (1) was used to establish known partial pressures against which to calibrate the mass spectrometer. The resulting calibration data are presented in Table III. The K factors, which are required in the application of Eq. (2) to calculate partial forepressures, are presented in Table IV. Application of the data in Tables III and IV is described in the analytical procedure, Section 4.3.

SECTION IV ANALYTICAL PROCEDURES

4.1 GENERAL

The analysis of each SAM sample started with the installation of the sample bottle on the processing apparatus (Fig. 2). The transfer of the LN₂ temperature condensables in the sample to a Type 1 sample trap proceeded as follows:

1. System Evacuation - Valve 2 was closed, valves 1 and 3 through 7 were opened, the mercury was raised in the buret, the mercury was drained from the manometer, and using first the mechanical pumps and then the diffusion pump, the sample trap and all lines back to the valve on the SAM sample bottle were evacuated. Valves 3, 5, 6, and 7 were then closed, and the diffusion pump heater was turned off.
2. Sample Trapping - The sample trap was cooled to LN₂ temperature, valve 5 and the valve on the SAM sample bottle were opened slightly, and the transfer of the condensables from the sample bottle to the sample trap was started. The 0- to 15-psia transducer was used to give a rough indication of system pressure during the transfer. The trapping process was continued for approximately 30 min with the 0°C samples and an hour for the -78 and -175°C samples.
3. Air Removal - After the system pressure stopped rising, as indicated by the transducer, the valve on the SAM sample bottle was opened completely, the bottle was heated gently, and the air in the sample trap was slowly pumped out through valve 6. Reduced

pumping continued for approximately 10 min and was followed by 2 or 3 min of hard pumping to completely evacuate the SAM sample bottle via the sample trap. At this time the transducer indicated zero pressure, and valves 4 and 5 on the sample trap were closed.

After completion of the sample transfer procedure, the sample trap was allowed to start warming. With valve 6 closed and while continuously pumping through valve 7, the mercury was raised in the manometer. As the sample trap warmed, valve 5 was opened and the trap pressure was monitored with the transducer.

If the sample contained much CO_2 , the mercury in the buret was lowered to maintain the trap pressure slightly above one atmosphere. After the sample had reached room temperature, an accurate measurement of the sample pressure was made with the manometer. Also, the total volume was found by adding the predetermined volumes of the sample trap, the manometer, the interconnecting lines, and the volume of the buret.

Since many of the samples contained little CO_2 , the final trap pressures were often below one atmosphere. In these cases, it was necessary to close valve 5, open valves 2 and 4, and fill the trap with helium to a regulated and measured pressure slightly above one atmosphere. This established the slight positive trap pressure necessary for drawing gas samples out of the trap by syringe.

At this point in the processing procedure, valves 4 and 5 were closed, and the sample trap was removed and weighed. The mass of liquid in the sample was then calculated by subtracting the predetermined mass of the trap either when evacuated or when filled with CO_2 , depending on whether the sample contained little or much CO_2 .

Knowing the total volume and pressure of the gaseous portion of the sample and the mass of the liquid portion of the sample, the sample processing procedure was completed and quantitative analyses could then proceed using the chromatograph and the mass spectrometer.

Two disadvantages in using the Type 1 traps during the sample processing procedure outlined above were: (1) The samples which were filled with helium were diluted to the extent that it was not possible to detect trace contaminants on the chromatograph, (2) Some of the samples contained less than 100 mg of liquid, and accurate mass determinations were not possible. To avoid these disadvantages, the Type 2 traps (Fig. 4) were used exclusively after the first seven days of testing.

When using the Type 2 traps, the buret and manometer (Fig. 2) were not required, and the mercury in these devices was drained into their reservoirs and valved off. Otherwise, the sample transfer procedure was the same as described previously up to the point where valves 4 and 5 on the Type 1 traps were closed (Step 3). On the Type 2 traps, the glass tubing was fused closed, and the traps were removed from the system while still at 78°K and under vacuum. The traps were then allowed to start warming. With most of the samples which had been originally trapped at 0 and -78°C, the pressure in the sample trap was below one atmosphere at room temperature. In these cases the traps were filled to a regulated and measured pressure slightly above one atmosphere by injecting helium through the septum. Many of the samples which had been originally trapped at -78 and -175°C contained a large amount of CO₂ which would have caused excessive pressure in the Type 2 traps at room temperature. In these cases, measured quantities of gas were withdrawn through the septum as the samples warmed. Gas removal continued until the trap pressure was only slightly above one atmosphere at room temperature. The device used to measure both the amount of gas removed and the final trap pressure was a U-tube manometer referenced to atmosphere and equipped with a hypodermic needle. This gas removal process generates a possible source of error, since it is assumed in the calculations that the gas removed is completely homogeneous and typical of the gas left in the trap. Analyses were made only on the gas left in the trap.

After the trap pressure had been set to slightly above one atmosphere either by injecting helium or by withdrawing CO₂, the trap was weighed. All analyses were then completed, and the trap was emptied, dried, and reweighed. The difference in the weights gave the mass of the liquid portion of the sample.

The sample processing procedures outlined in this section provided three specific results: (1) All 77°K condensables in each SAM sample bottle were transferred to a trap from which small portions of both the liquid and vapor could conveniently be withdrawn for analysis; (2) The total mass of liquid in each sample was determined, (3) The total volume of the trap vapor at standard temperature and pressure (STP) was determined. These data were required to complete the analytical procedures which are described in the following sections.

4.2 CHROMATOGRAPH ANALYSIS PROCEDURE

After completing the processing procedure described in Section 4.1, portions of both the sample trap liquid and the vapor were withdrawn by syringe and analyzed successively on the chromatograph. The sample

sizes were always 10 μ l of liquid and 2-5 cc of gas. The retention data in Table II were used to identify the peaks on the resulting chromatograms, the sensitivity data in the table were used to calculate the total mass of each compound in each liquid and vapor sample. The expression used to calculate the mass of each compound was:

$$\text{Mass} = [S \times \text{Peak ht. (or area)}] \times \frac{\text{Total wt. (or vol.) of sample}}{\text{Wt. (or vol.) of sample injected}} \quad (4)$$

The total weight of each liquid or the total volume of each vapor sample used in this calculation was the value determined during the sample processing procedure described in Section 4.1. The volumes of all vapor samples were reduced to standard conditions before this calculation was made.

4.3 MASS SPECTROMETER ANALYSIS PROCEDURE

As described in Section 2.3, portions of the liquid and the vapor in each sample were introduced successively into the mass spectrometer gas inlet system for analysis by the mass spectrometer. A mass spectrometer analysis consisted both of a background and a sample spectrum scan. The spectra were recorded on a strip chart, and peak readings with the background subtracted out were transferred to data sheets of the type shown in Table V. The data reduction procedure applied to each data sheet is outlined by the following steps which were incorporated into a computer program:

1. Using the mass spectrometer calibration data, Table III, each mass spectrum was reduced on the computer to obtain the absolute partial pressure of each compound in the ion source region. An outline of this part of the computer program is presented in the Appendix.
2. The partial pressure of each compound in the ion source region was multiplied by the appropriate K factor, (Table IV) to obtain the partial pressure of that compound on the forepressure side of the leak.
3. The resulting partial forepressure of each compound was divided by the total leak forepressure to obtain the mole fraction of each compound.
4. The mole fraction of each compound was multiplied by the total number of moles in the sample to obtain the number of moles of each compound in the sample.
5. The number of moles of each compound was multiplied by the molecular weight to obtain the mass of the compound in the sample.

The total number of moles of vapor samples used in Step 4 was calculated from the ideal gas law using the total pressure and volume of the sample measured during the sample processing procedure (Section 4.1). The total number of moles of each liquid sample was calculated by dividing the total mass of liquid, determined during the sample processing procedure, by the molecular weight of pure water.

The mass spectrometer data on each sample were printed out on a data sheet of the type shown in Table XXXIV. The first five columns in this table show, respectively, the compounds, the partial pressure of each compound in the ion source during the analysis, the partial forepressure of each compound, the total number of moles, and the total mass, in grams, of each compound in the sample. The last three columns in the table are not directly associated with the first five columns. These three columns show the data check described in the Appendix. They list, respectively, the mass numbers of the peaks used in the data reduction procedure, the measured peak heights in amperes of the peaks used, and the difference between the measured peak heights and the peak heights that were calculated from the partial pressure solutions listed in the second column of the table.

SECTION V TEST RESULTS

In accordance with the basic test requirements, the mass of each quantitatively identified compound in each SAM sample is reported in Tables VI through XXXII. The tables show the amount of each identified compound found in the liquid and in the vapor of each sample. Appropriate comments concerning each analysis are made at the bottom of each analysis report. The cylinder volumes listed on each sheet are the volumes of the SAM sample bottles in which the samples were originally trapped. Measurements of these volumes were required by SAM, and after the samples had been removed, the volumes were determined by simple expansions into a calibrated volume.

The liquid portions of the SAM samples which had been originally trapped at -175°C were analyzed by chromatograph only because, in all cases, there was not enough liquid for analysis on both the chromatograph and mass spectrometer.

Analyses of a standard gas mix supplied by SAM for interlaboratory checking purposes are given in Table XXXIII (chromatograph analysis) and in Table XXXIV (mass spectrometer analysis). This mix was

reported by SAM to contain ethane, vinyl chloride, acetaldehyde, acetone, diethyl ether, methyl acetate, methylene chloride, hexane, ethylene dichloride, benzene, heptane, and toluene. The chromatogram obtained on the standard mix (Fig. 10) failed to resolve the peaks of acetaldehyde, acetone, and diethyl ether. Also, the chromatogram showed impurities consisting of pentane, methyl ethyl ketone, and unknowns at retention ratios 0.415 and 1.60. The mass spectrometer results, column five of Table XXXIV, agreed generally with the chromatogram results and indicated that the acetaldehyde had disappeared and impurities consisting of pentane, methyl ethyl ketone, H_2S , and ethanol were present. Unlike the chromatograph, the mass spectrometer gave quantitative results on acetone and diethyl ether. The impurities found may have been products of reaction between acetaldehyde and other constituents in the bottle, since this sample was not run until the fifth week after receipt. During preliminary chromatograph calibrations with similar mixtures, evidence of such reactions between constituents had been observed.

SECTION VI DISCUSSION OF RESULTS

6.1 GENERAL

The data in Tables VI through XXXII were compiled from both the chromatograph and the mass spectrometer results. During the first seven days of the test (Tables VI through XII) the Type 1 traps were used as described in Section 2.1. When these traps were filled to slightly above one atmosphere with He, as was required for introducing the samples into the chromatograph, many samples were diluted to the extent that peaks could not be detected on the chromatograph. Consequently, several of these samples were not filled with He, and the trap vapors were analyzed by mass spectrometer only. Therefore, the majority of the data in Tables VI through XII is mass spectrometer data. During the remaining 20 days of the test (Tables XIII through XXXII) the small volume, Type 2, traps were used. Although this adversely affected the mass spectrometer results, it increased the sensitivity of the analytical procedure with the chromatograph, and useful chromatograph data were obtained on all remaining samples. Consequently, the majority of the data reported in Tables XIII through XXXII is chromatograph data. In cases where the mass spectrometer and chromatograph results disagreed, the chromatograph data were considered to be more accurate and were reported on the analysis sheet.

In compiling Tables VI through XXXII, the mass spectrometer was used to resolve the ether/ethanol and chloroform/hexane interference problems in the chromatograph data. Data relating to CO_2 , Freon 11,[®] HF, and H_2S are all mass spectrometer results. The mass spectrometer also provided positive identifications of ethylene and tetrahydrofuran, after which the quantities in the samples could be calculated from the chromatograms.

Since atmospheric gases, other than CO_2 , were of no interest to SAM, no attempts were made to analyze for N_2 , O_2 , or argon. In various samples there were some low level contaminants which could not be identified conclusively. Because of interference problems neither instrument gave satisfactory analyses for the lighter hydrocarbons or ammonia at low concentrations. The chromatograph was insensitive to ammonia but did indicate the probable presence of methane.

6.2 TYPICAL CHROMATOGRAMS

A set of chromatograms taken on a typical set of SAM samples is presented in Figs. 11 through 16. While running chromatograms, it was noticed that the retention times of some compounds varied slightly, depending on whether the sample injected into the chromatograph was liquid or gas. The variations (in the first part of the chromatogram, before the expulsion of steam) were probably caused by the effects of vaporization and by the presence of water. The retention times were also slightly influenced by the concentration of various compounds. In spite of these variations, the only serious calibration and identification problems were at the beginning of each chromatogram. Methane, ethane, ethylene, and propane all came out very close (Table II), and in most cases it was not possible to identify these four gases conclusively.

6.3 DISCUSSION OF MASS SPECTROMETER RESULTS

The computer data sheets for four typical samples are shown in Tables XXXV through XXXVIII. As explained in the Appendix, a criterion for judging the validity of the results of an analysis is that the $\text{H}-\text{H}_{\text{cal}}$ values should be small compared to the measured H values at each mass number. Using this criterion, a study of the last two columns of Tables XXXV through XXXVIII shows that the quality of the mass spectrometer data was not consistent. A study of all of the 120 data sheets compiled indicated that the results on the less complicated vapor analyses were generally good, as in Table XXXV, or fair as in

Table XXXVI. Furthermore, the study demonstrated that the results of the more complicated vapor samples were generally poor as are the results shown in Table XXXVII. Many of the $H-H_{cal}$ values in Table XXXVII are much larger than the experimental H values. Consequently, part of the quantitative data shown in column five can be expected to be in error. Table XXXVII shows 52 mg of ethanol and 175.7 mg of acetaldehyde. The chromatogram on this sample gave 0.008 mg of ethanol and less than 0.0001 mg of acetaldehyde (see Table XXIII). Such gross errors in the mass spectrometer results are not simple measurement errors. They result mainly from faults in the data reduction procedure, and specifically, they were generated in the steps in the data reduction procedure (see Appendix) where groups of equations were solved simultaneously for exact algebraic solutions. These errors could probably have been reduced by further data reduction effort. However, this effort would not have been worthwhile because the chromatograph provided quantitative data for most of the compounds on which poor mass spectrometer results were obtained.

In spite of the data reduction uncertainties, useful quantitative data were obtained from data such as Table XXXVII. Peaks, either free of interference or virtually so, were generated by carbon dioxide, hydrogen sulfide, diethyl ether, benzene, chloroform, toluene, Freon 11, O-xylene, carbon tetrachloride, and tetrachloro-ethylene at mass numbers 22, 34, 74, 78, 83, 92, 101, 105, 117, and 166, respectively, (see Table III). Useful quantitative data were obtained for these components.

Results of a typical liquid analysis are shown in Table XXXVIII. The quantitative results of the liquid analyses were generally in considerable disagreement with the chromatograph. The mass spectrometer data generally indicated quantities of contaminants some two to three decades higher than did the chromatograph. The results showed that the concentrations of the trace contaminants in the vapor phase in the ion source were enhanced, and the resulting quantitative data were too high. The data suggests that after the liquid samples were injected into the vacuum system the water was adsorbed by the system to a much greater extent than were the trace contaminants in the sample. Consequently, almost all of the data reported in Tables VI through XXXII on the liquid samples are chromatographic results. Exceptions are hydrogen fluoride and CO_2 . Since the chromatograph was insensitive to these components, the mass spectrometer data were reported. The mass spectrometer data on hydrogen fluoride are considered to be accurate because, in the calibration, HF was introduced along with water in a 100-ppm ratio. Consequently, all significant systematic errors caused by water vapor adsorption were accounted for in the calibration for HF. Such a calibration procedure could have been applied to all the

compounds. However, this would have further increased the already lengthy calibration effort with few additional returns.

Throughout the test, the mass spectrometer provided useful qualitative data which made it possible to identify certain chromatograph peaks. An example of such data is illustrated by the SAM sample spectrum shown in Table V. A study of this spectrum indicated that the peaks at 71 and 72 were generated by a compound not included in the calibration gases, Table III. From the American Petroleum Institute catalog of mass spectral data it was found that tetrahydrofuran generated a fragment pattern similar to that found in Table V at mass numbers 39, 40, 41, 42, 43, 71, and 72. A subsequent calibration of the chromatograph for tetrahydrofuran gave a retention ratio corresponding to an unknown peak in the chromatograph data. The unknown peak was then designated to be tetrahydrofuran, and the quantity in the sample was calculated from the chromatograph data.

Table V also illustrates the basic problem encountered in mass spectrometer analyses of samples which consist primarily of one component (e g. H_2O or CO_2). The largest peak in the spectrum is the water peak at mass 18. The $6.9 \cdot 10^{-9}$ amp indicates that the partial pressure of H_2O in the ion source was $9 \cdot 10^{-6}$ torr. To avoid filament damage and to stay within the linear operating region of the mass spectrometer, the ion source pressure must be held below $1 \cdot 10^{-5}$ torr. Since the ion source pressure could not be increased above this value, most of the trace contaminant peaks were of the same order of magnitude as the system background peaks. The background peaks were usually in the 10^{-12} - and 10^{-13} -amp ranges. The minimum detectable ion current on the Bendix 17-210V is about $1 \cdot 10^{-13}$ amp. Measurements of trace contaminant peaks on the 10^{-12} - and 10^{-13} -amp ranges are subject to the following significant sources of error.

1. Changes in the system background - There was much evidence of changes in the background when the sample flow was started through the ion source, whereas, in the data reduction, the background is assumed to remain constant.
2. Errors in low level ion current measurements - Considering electrical noise, leakage currents, and slight drifts in the electrometer zero point, the accuracy of ion current measurements on the 10^{-13} -amp range was probably no better than the ± 20 percent of the reading.

Thus, high concentrations of H_2O and CO_2 compared to those of the trace contaminants tend to reduce the applicability of the mass spectrometer to quantitative trace contaminant analysis.

SECTION VII CONCLUSIONS

The sample processing procedure using the Type 2 traps proved to be generally satisfactory. Some improvements could have been realized when processing the samples which contained more than 16 cc (the trap volume) of CO_2 at STP. In future tests, provisions should be made to allow the trap vapor to mix more completely at room temperature before taking the sample for analysis.

The test results presented in Section V satisfy most of the basic test requirements. Quantitative data on the lighter hydrocarbon gases and ammonia were desired but could not be obtained because of their low concentrations and because of interference problems. The chromatograph indicated the presence of light hydrocarbon gases but did not provide conclusive identification. During the last week of the test, ethylene did become concentrated enough to be identified on the mass spectrometer, and the quantities present were calculated from the chromatograph data.

With the exceptions mentioned above, the analytical procedures were adequate for the test requirements. However, many improvements in the analysis procedures could be realized. Specifically, the quantitative analyses attempted with the mass spectrometer required a very lengthy calibration and data reduction effort, and most of the results were still only qualitative. During the test, it became obvious that both mass spectrometer and chromatographic instruments are necessary to perform unambiguous analyses, but it now appears that a faster analysis procedure would result from using the mass spectrometer for identification only. After positive identification, it is much easier to reduce chromatographic data than to resolve the mass spectra of complex mixtures. Furthermore, if the cracking patterns of two components are similar and if the ratio of the concentrations is on the order of 100:1 or greater it becomes impossible to resolve the ion current contribution of the component of lower concentration.

A more satisfactory analytical procedure could probably be devised by running each sample on two different types of chromatographic columns and using a mass spectrometer to sample the gas at the output of each retention column. The mass spectrometer would be used either to eliminate ambiguities in the chromatograph data or as the primary detector. This analytical procedure would require a fast scanning, high resolution, high sensitivity mass spectrometer with an oscilloscope display. This type of instrumentation is commercially available.

APPENDIX

The reduction of each mass spectrum to the absolute partial pressures of the compounds in the ion source region was the most complicated step in the data reduction program. After reviewing several sets of test data, it was assumed that each of the 37 gases shown in the first column of Table XXXIV were possible constituents of the processed samples. The computer program was set up assuming the samples to contain no compounds other than these 37. The peak heights of the 37 mass numbers listed under the mass number column, Table XXXIV, were used in the data reduction. In general, these 37 mass numbers correspond to the major peaks of the 37 different gases. There were some exceptions to this, for example, the CO_2 partial pressure in each sample was calculated from the peak height of mass number 22.

Since the individual spectra of all components of a gaseous mixture in a mass spectrometer ion source add linearly to produce the spectrum of the mixture, the partial pressures of the 37 gases satisfy the system of equations (Ref. 2):

$$\begin{aligned} h_{11}P_1 + h_{12}P_2 + \dots + h_{1n}P_n &= H_1 \\ h_{21}P_1 + h_{22}P_2 + \dots + h_{2n}P_n &= H_2 \\ \vdots &\vdots \\ h_{n1}P_1 + h_{n2}P_2 + \dots + h_{nn}P_n &= H_n \end{aligned}$$

where $n = 37$. Defining $1 \leq \ell$, $m \leq 37$, P_m in these equations is the absolute partial pressure of gas m in the ion source region, $h_{\ell m}$ is the mass spectrometer sensitivity in amp/torr (Table III) for mass number ℓ of gas m , and H_ℓ is the peak height in amperes measured at mass number ℓ during the analysis of a sample.

The coefficient matrix is

$$h = \begin{pmatrix} h_{11} & h_{12} & \dots & h_{1n} \\ h_{21} & h_{22} & \dots & h_{2n} \\ \vdots & \vdots & & \vdots \\ h_{n1} & h_{n2} & \dots & h_{nn} \end{pmatrix}$$

If we define

$$P = \begin{pmatrix} P_1 \\ P_2 \\ \vdots \\ P_n \end{pmatrix} \quad \text{and} \quad H = \begin{pmatrix} H_1 \\ H_2 \\ \vdots \\ H_n \end{pmatrix}$$

then the system of 37 equations can be written as a matrix equation (Ref. 2):

$$P = h^{-1}H$$

The first computer program was written to calculate h^{-1} and the matrix product $h^{-1}H$. However, this procedure was not satisfactory because it produced negative values for some of the elements in P . That is, it gave negative partial pressures. The apparent reason for these negative results was an inconsistency in the elements of the H matrix (i. e. the experimental data on the samples). To avoid these negative results, a second program was prepared.

This second program employed the method of substitution to repeatedly reduce the order of the set equations until all 37 unknowns were calculated. Each substitution generated a new set of H_g data. These values were tested to see if any were zero or negative, and if so, the corresponding equation(s) was eliminated. At the same time the partial pressures of the gases having the largest h_{gm} in the eliminated equations were set equal to zero. This procedure eliminated negative results. The solution of the 37 equations proceeded as follows:

Six of the 37 original simultaneous equations were equations in one unknown and were solved first. This gave the partial pressures of He, CO_2 , H_2S , tetrachloroethylene, O-xylene, and 1, 1, 1 trichloroethane. The six partial pressures were substituted back into the 37 equations, and a new set of 31 equations in 31 unknowns was obtained.

In the new set it was possible to select a set of four equations in four unknowns. These four were solved to give the partial pressures of Freon 11, 1, 1 dichloroethylene, toluene, and benzene. These four partial pressures were substituted back into the set of 31 equations to obtain still another set of 27 equations in 27 unknowns.

Out of the set of 27 equations it was possible to select and solve three equations in three unknowns to get the partial pressures of vinyl chloride, 1, 1 dichloroethane, and ethylene dichloride. These three partial pressures were substituted back into the 27 equations to obtain a new set of 24 equations in 24 unknowns.

In this new set of 24 equations, the equation corresponding to the mass number 100 data contained only the partial pressure of heptane which was calculated directly. Also, from this set of 24 equations it was possible to select three equations in three unknowns. These corresponded to the data at mass numbers 49, 83, and 117 and were solved simultaneously to obtain the partial pressures of methylene

chloride, chloroform, and carbon tetrachloride. These four new partial pressures were substituted back into the set of 24 equations to obtain still another set of 20 equations in 20 unknowns.

In this set of 20 equations, the smallest number of equations that could be selected having the same unknowns was ten. These ten equations were solved using the matrix inverse program outlined earlier. The data used corresponded to mass numbers 39, 42, 43, 45, 46, 57, 58, 59, 72, and 74, and the partial pressures of propane, acetaldehyde, ethanol, acetone, isopropyl alcohol, methyl ethyl ketone, pentane, diethyl ether, methyl acetate, and hexane were calculated. These ten partial pressures were substituted back into the set of 20 equations to obtain a newer set of 10 equations in 10 unknowns.

Out of this set of 10 equations the three equations corresponding to mass numbers 26, 30, and 31 were solved to get the partial pressures of ethylene, ethane, and methanol. Also, the equations corresponding to mass numbers 20 and 40 were solved simultaneously to get the partial pressures of argon and hydrogen fluoride. These five resulting partial pressures were substituted back into the set of 10 equations to obtain still another set of five equations in five unknowns.

The two of these five equations corresponding to mass numbers 18 and 32 were equations with one unknown and were solved directly for the partial pressures of oxygen and water vapor. These two partial pressures were substituted back into the five equations to obtain a set of three equations in three unknowns. These three equations corresponded to mass number 14, 16, and 28, and were solved simultaneously to obtain the partial pressures of methane, nitrogen, and carbon monoxide.

As a final step, the 37 resulting partial pressures were substituted back into the original set of 37 equations, and values of H_g were calculated for the 37 mass numbers used in the data reduction. These values were subtracted from the measured H_g at each mass number and the results tabulated. For example, the last three columns of Table XXXIV show the mass numbers, the measured H_g , and the differences between the measured H_g and the calculated H_g . If the tabulated differences were small compared to the measured peak heights then the results of a particular analysis were assumed to be valid. The results were then incorporated into the analysis report along with the chromatograph data (see Section 6.1).

REFERENCES

1. Sherrell, F. G. and Mathews A. J. "A High Vacuum Calibration System." AEDC-TDR-64-275 (AD 454480), January 1965.
2. Robertson, A. J. B. Mass Spectrometry. John Wiley and Sons, Inc., New York, 1954.

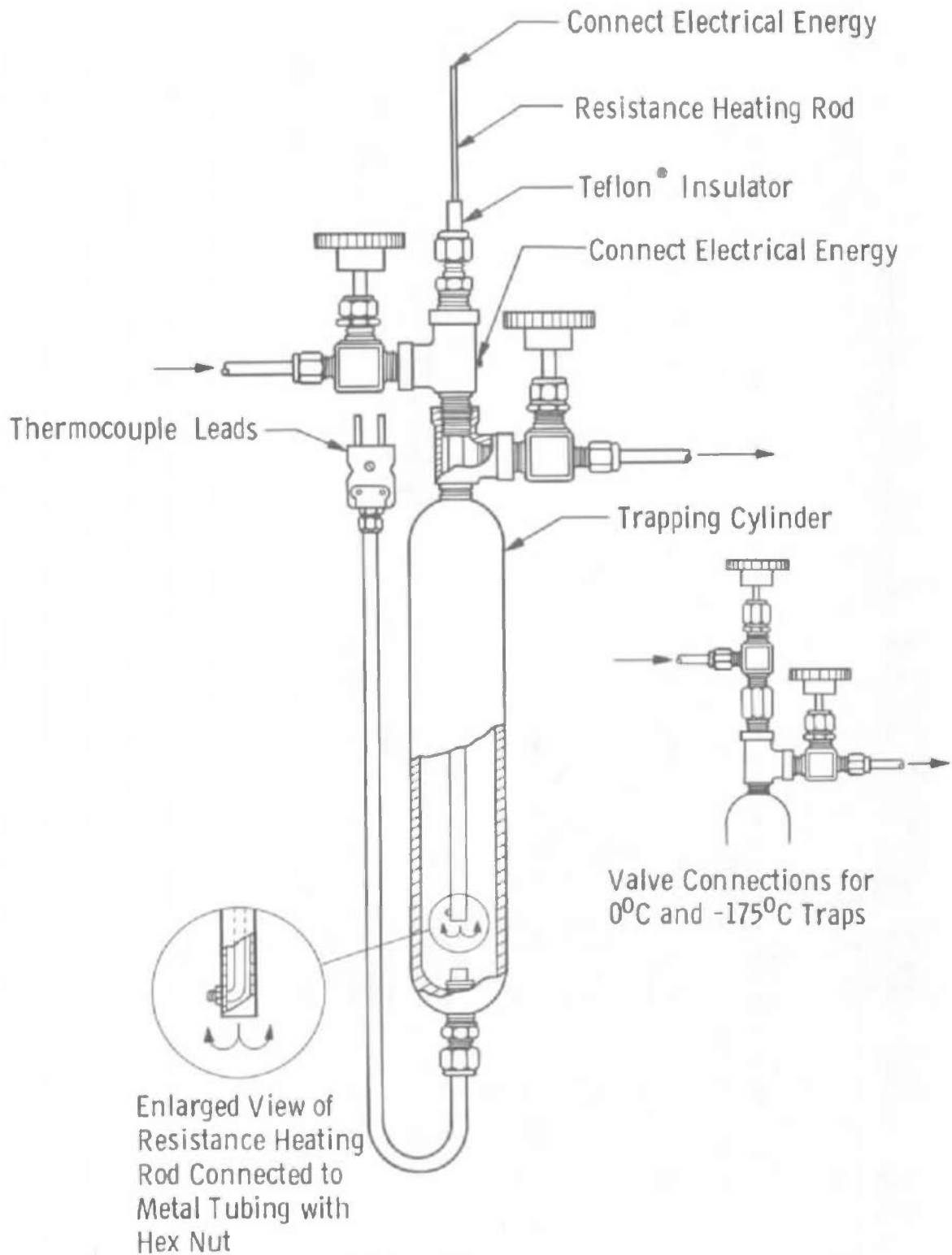


Fig. 1 Multistage Cryogenic Trapping System

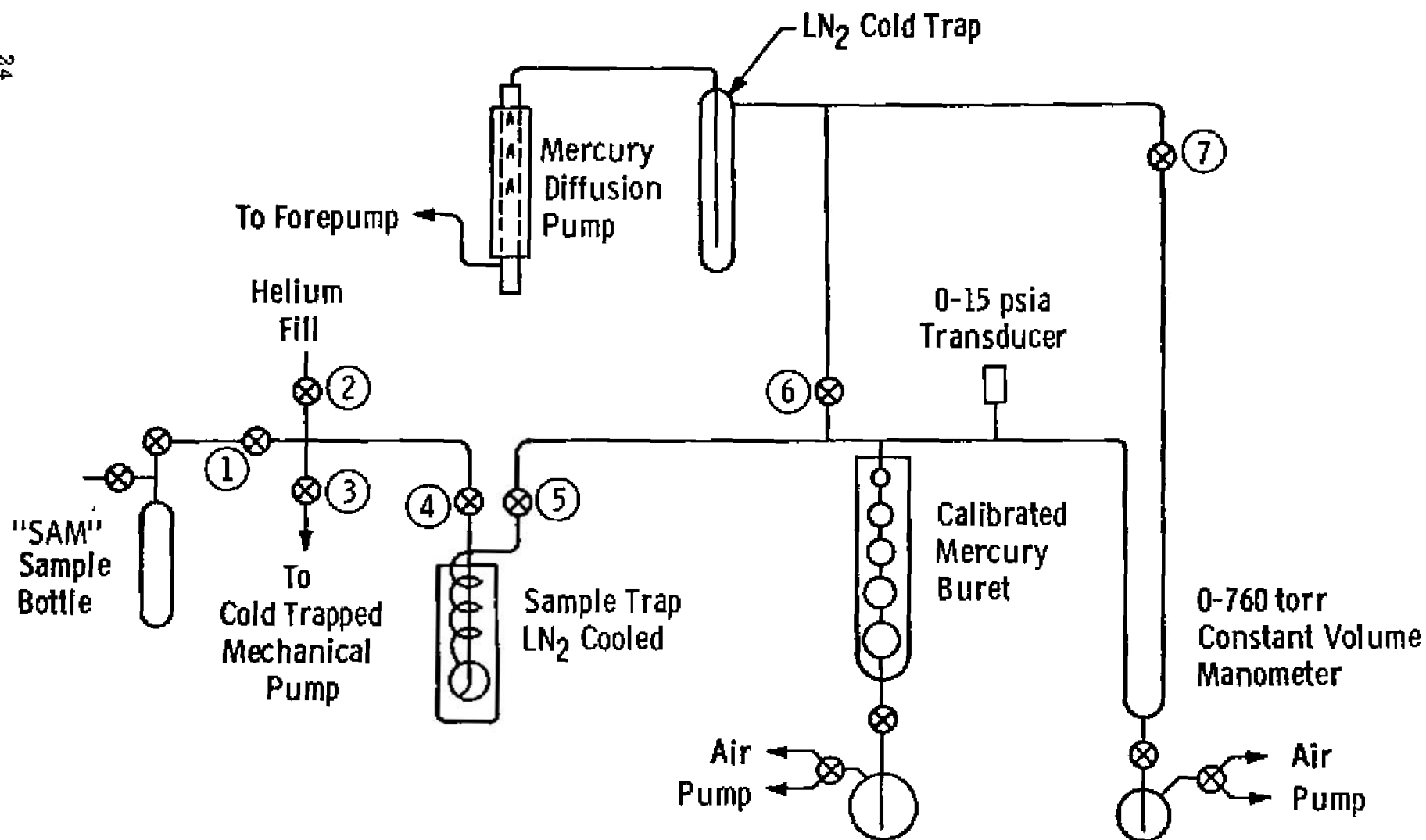


Fig. 2 Sample Processing Apparatus

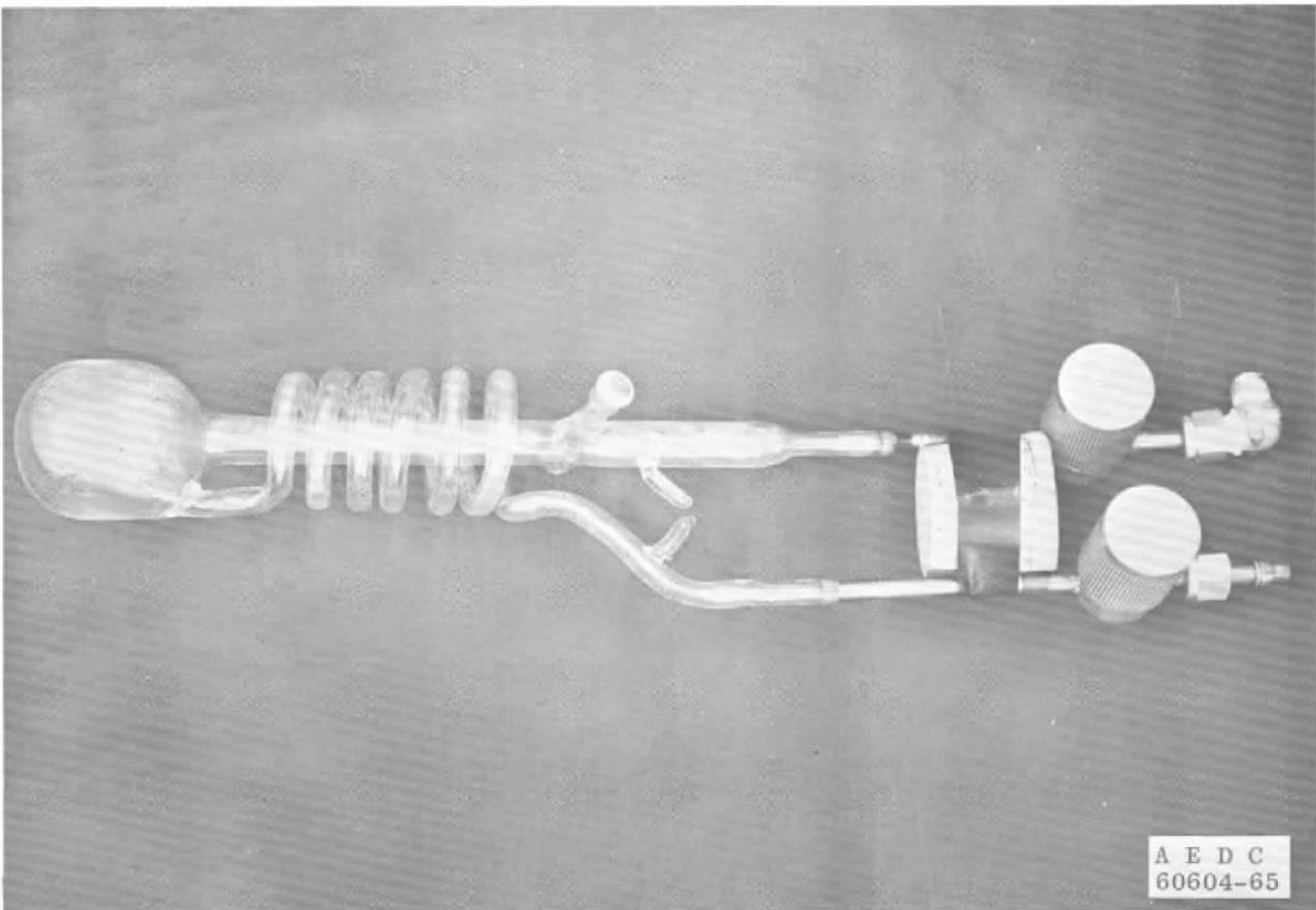


Fig. 3 Traps, Type 1, Ecological Sample Analysis Test

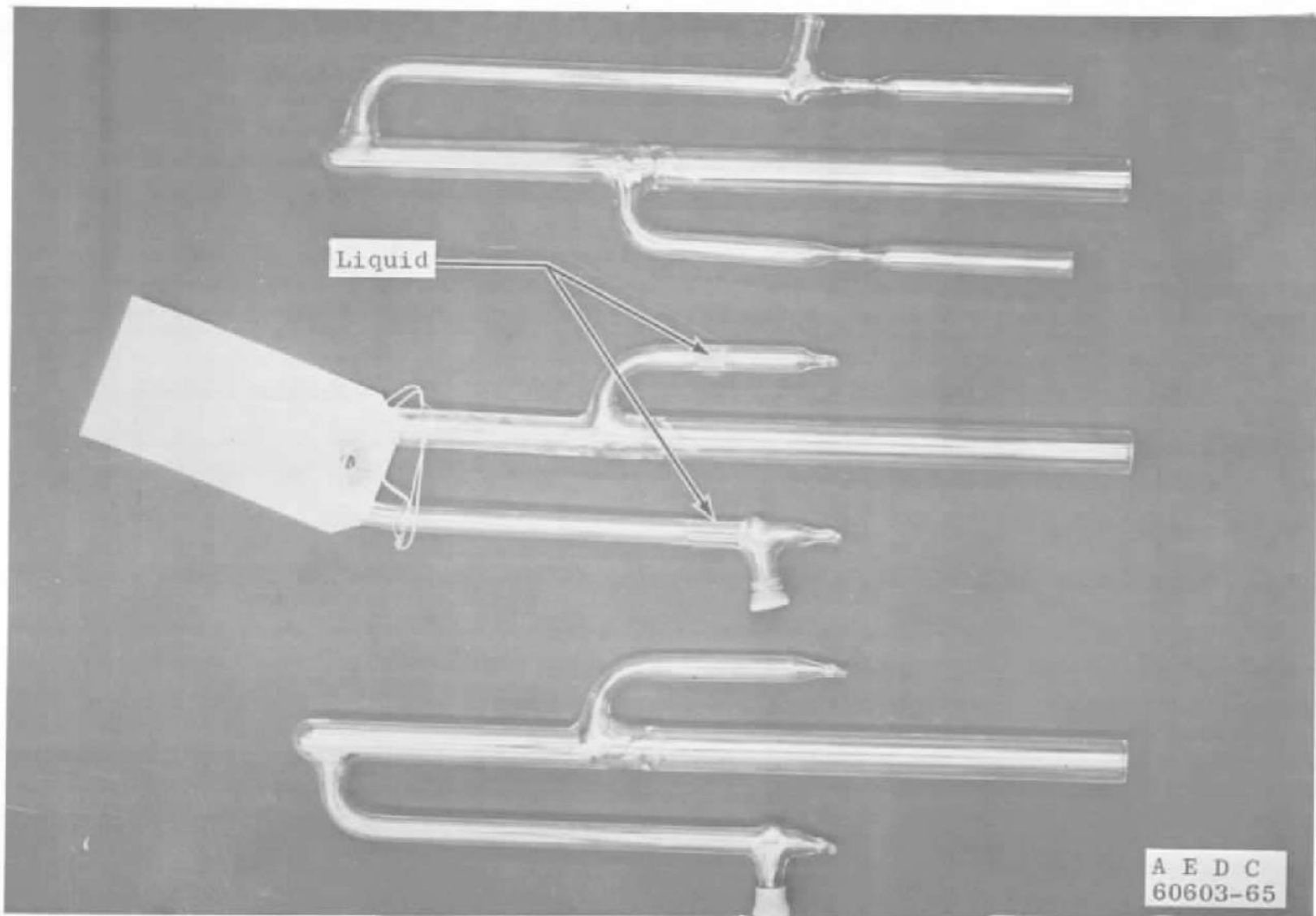


Fig. 4 Traps, Type 2, Ecological Sample Analysis Test

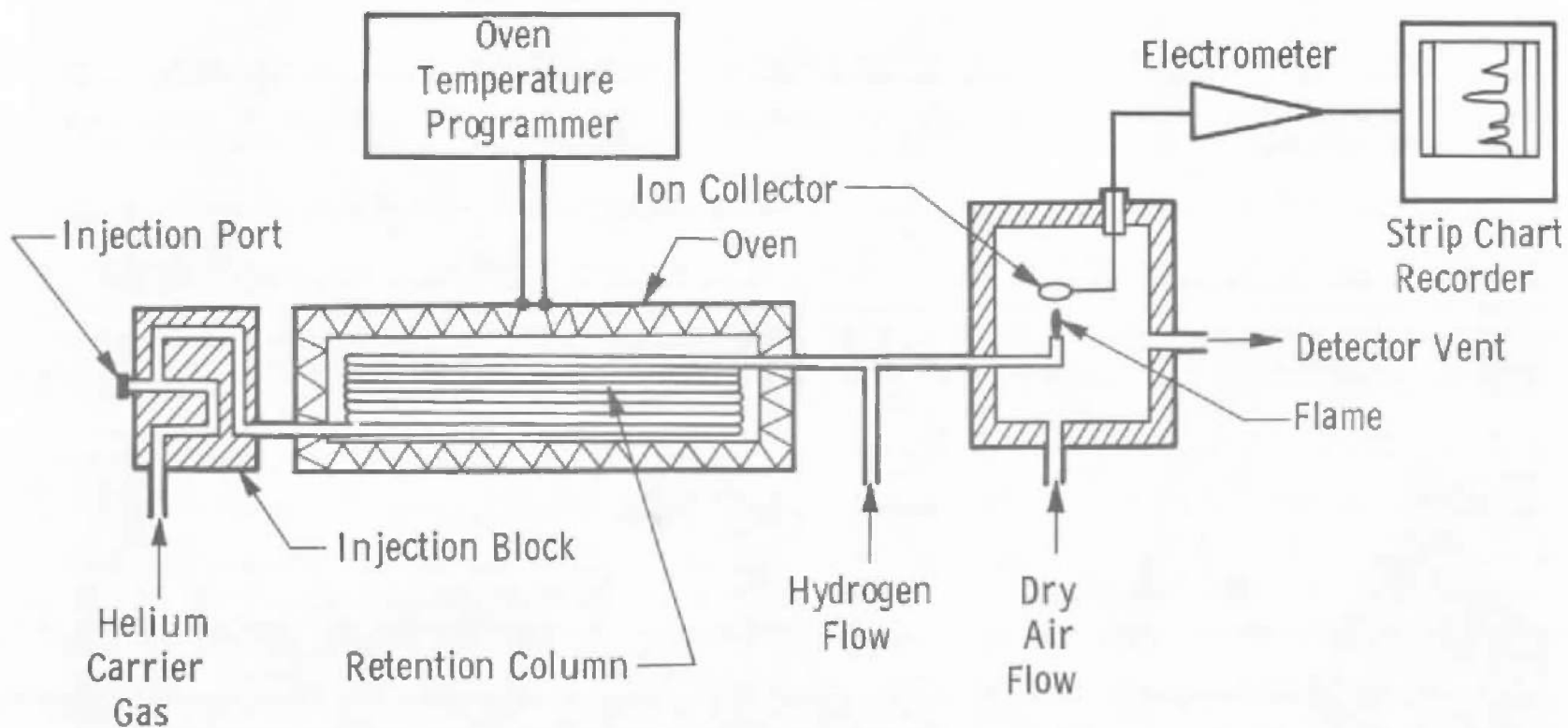


Fig. 5 Schematic of Chromatograph with Flame Ionization Detector



Fig. 6 F & M Scientific - Chromatograph

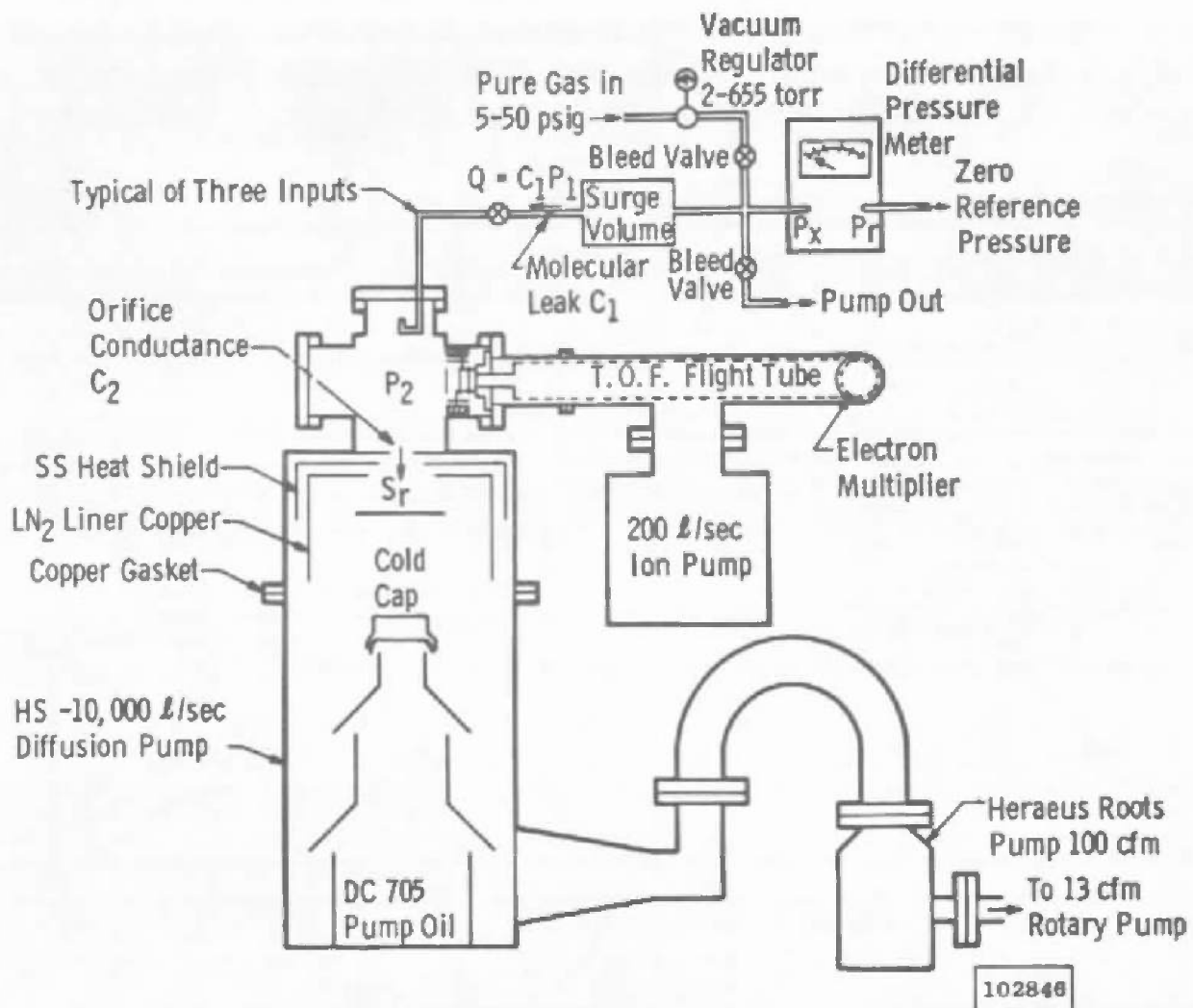


Fig. 7 Mass Spectrometer Calibration System Schematic

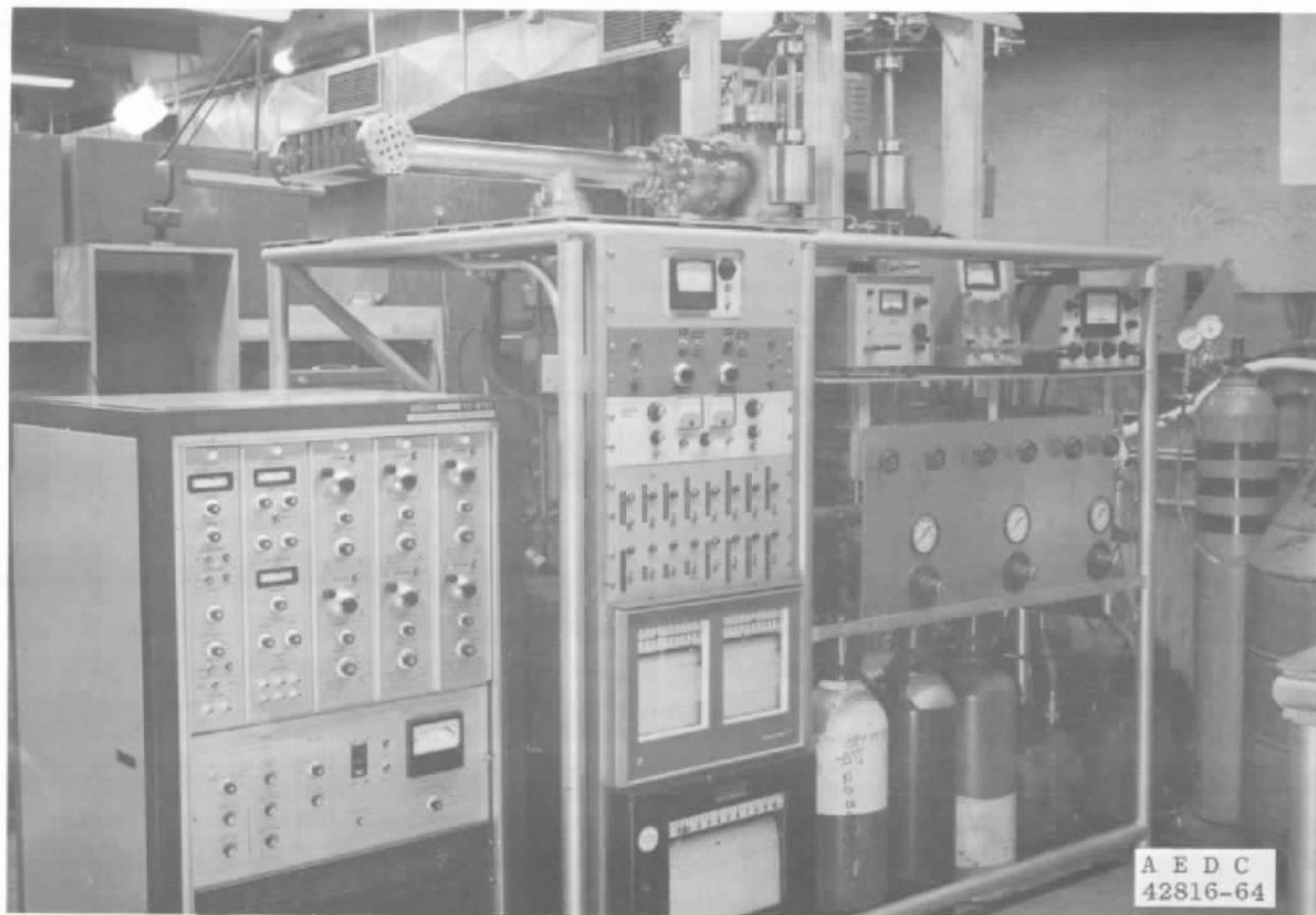


Fig. 8 Bendix 17-210V Mass Spectrometer and Calibration System

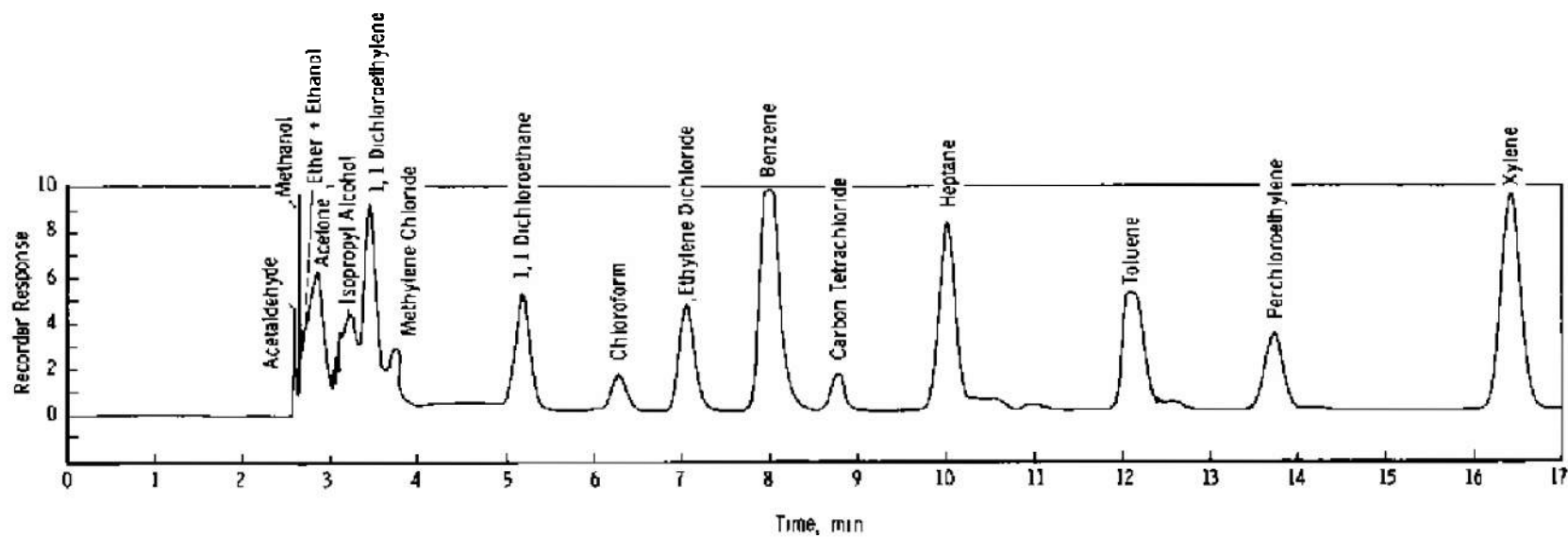


Fig. 9 Standard Chromatograph Retention Times

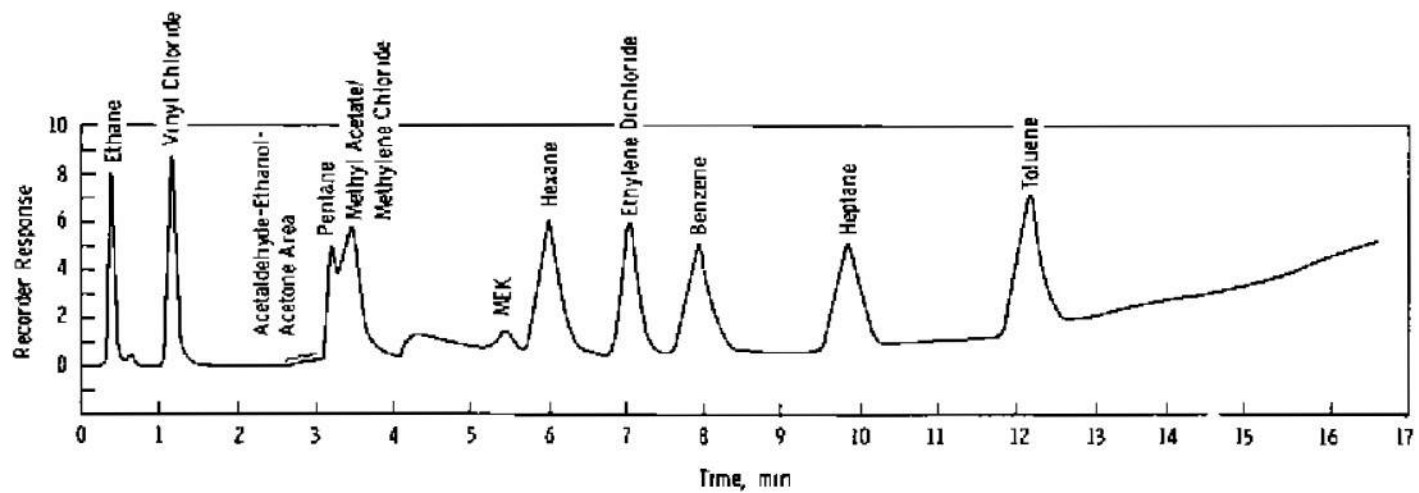


Fig. 10 Chromatogram of Standard Gas Mix (2.5-cc Gas Sample)

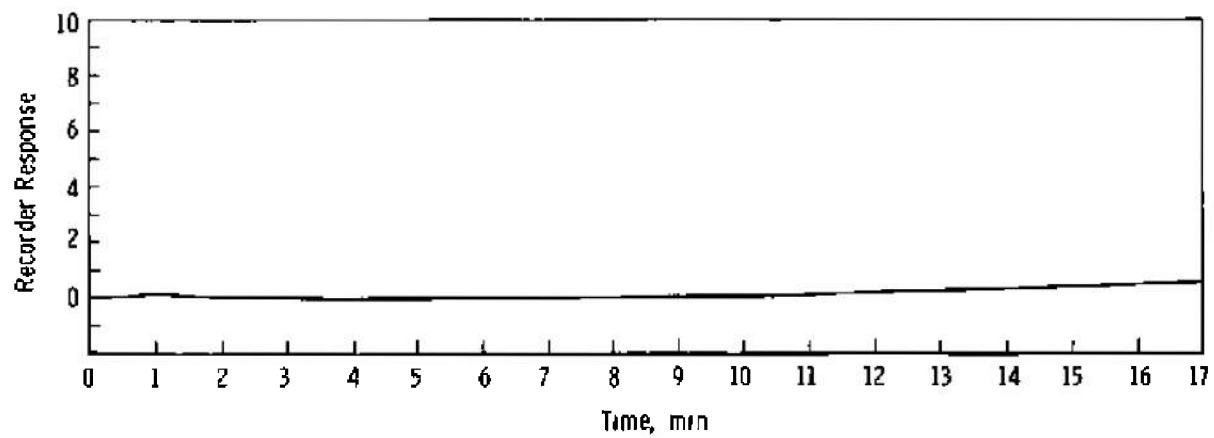


Fig. 11 Chromatogram of Set 19, 0°C (2 5-cc Gas Sample)

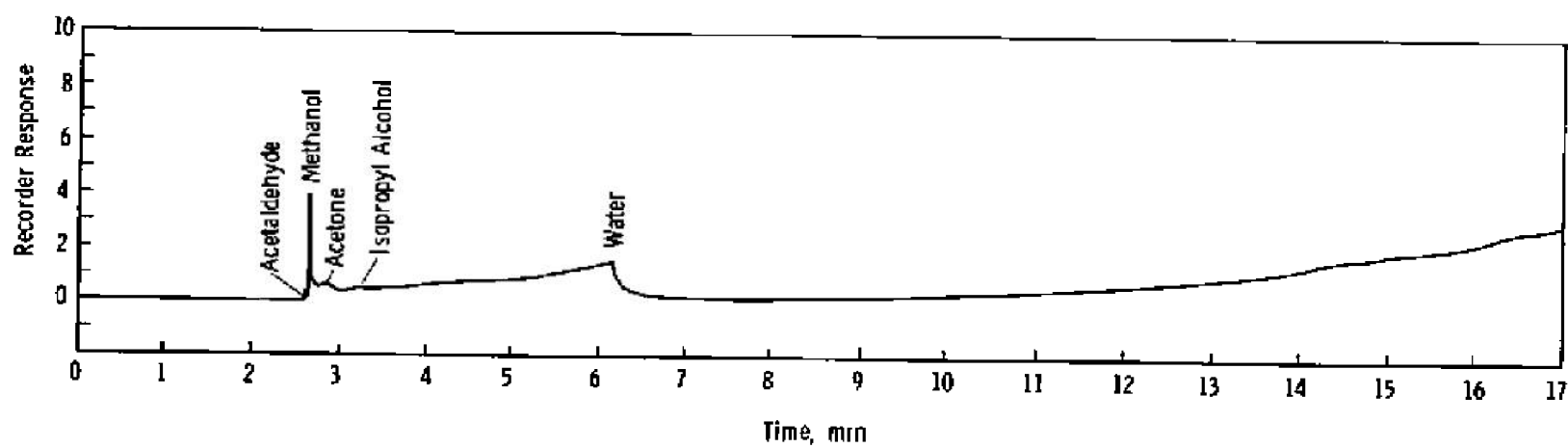


Fig. 12 Chromatogram of Set 19, 0°C (10- μ l Liquid Sample)

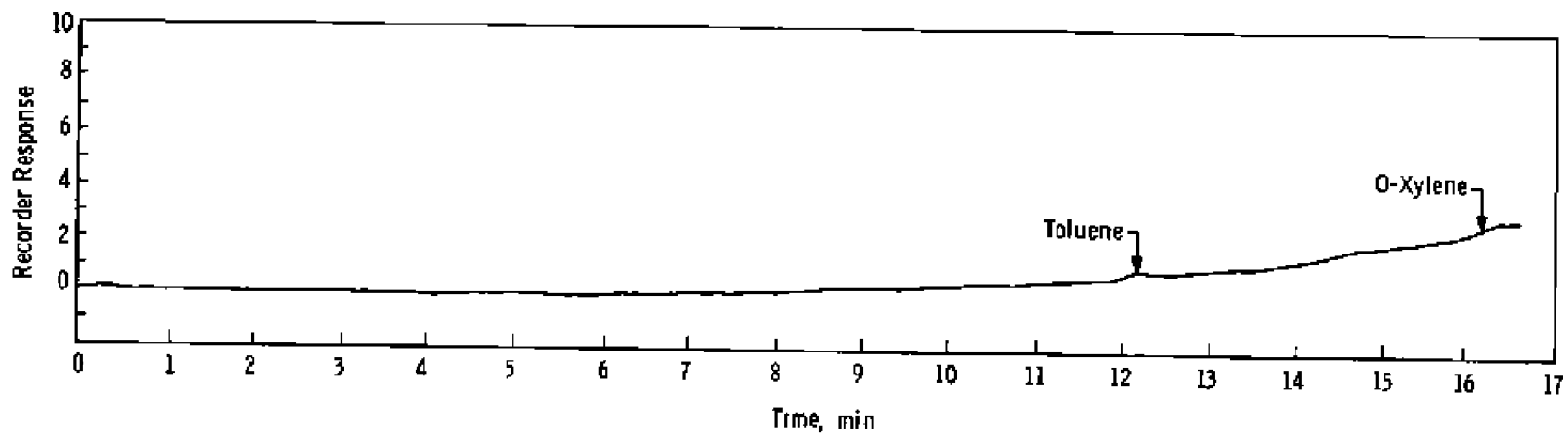


Fig 13 Chromatogram of Set 19, -78°C (2.5-cc Gas Sample)

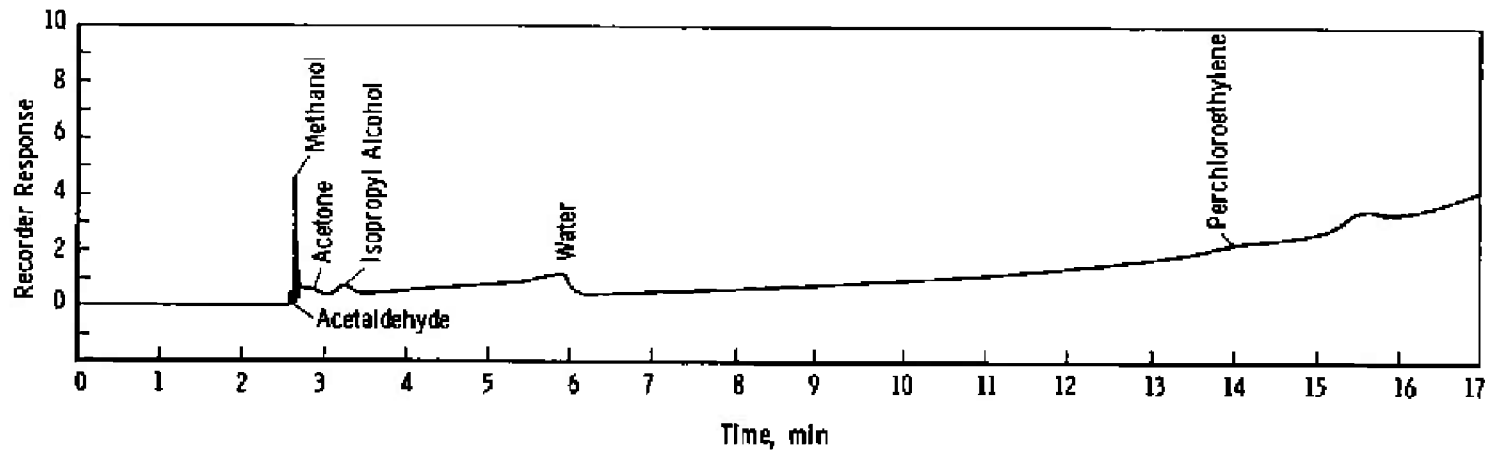


Fig. 14 Chromatogram of Set 19, -78°C ($10\text{-}\mu\text{l}$ Liquid Sample)

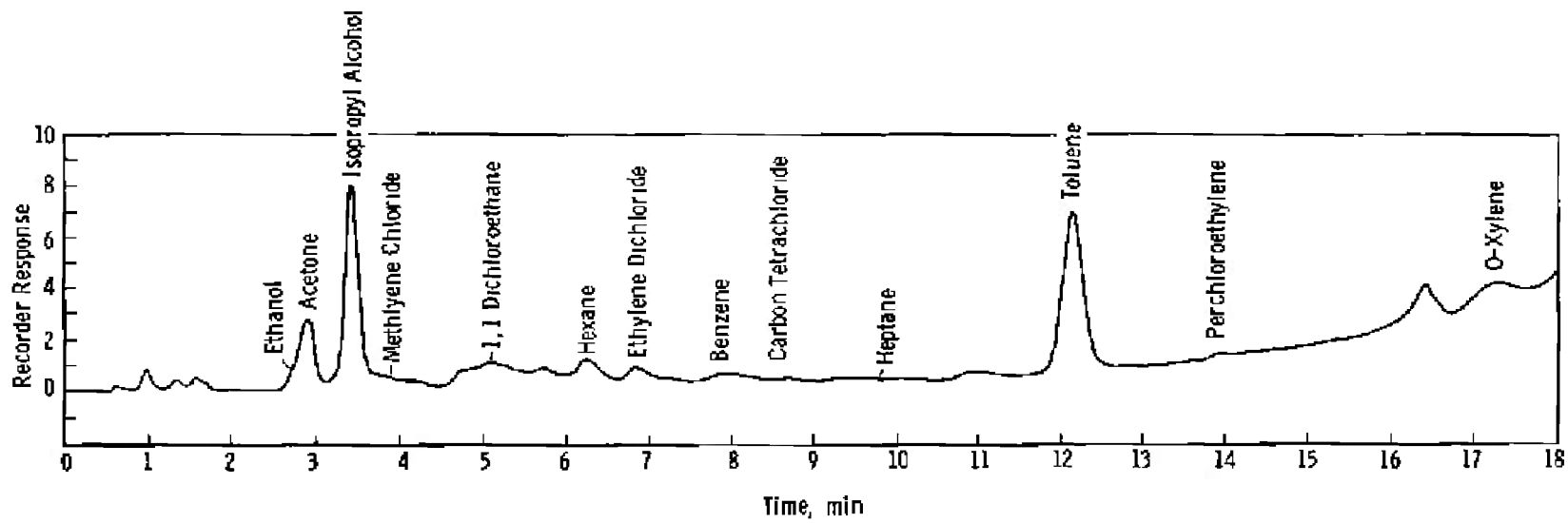


Fig. 15 Chromatogram of Set 19, -175°C (2.5-cc Gas Sample)

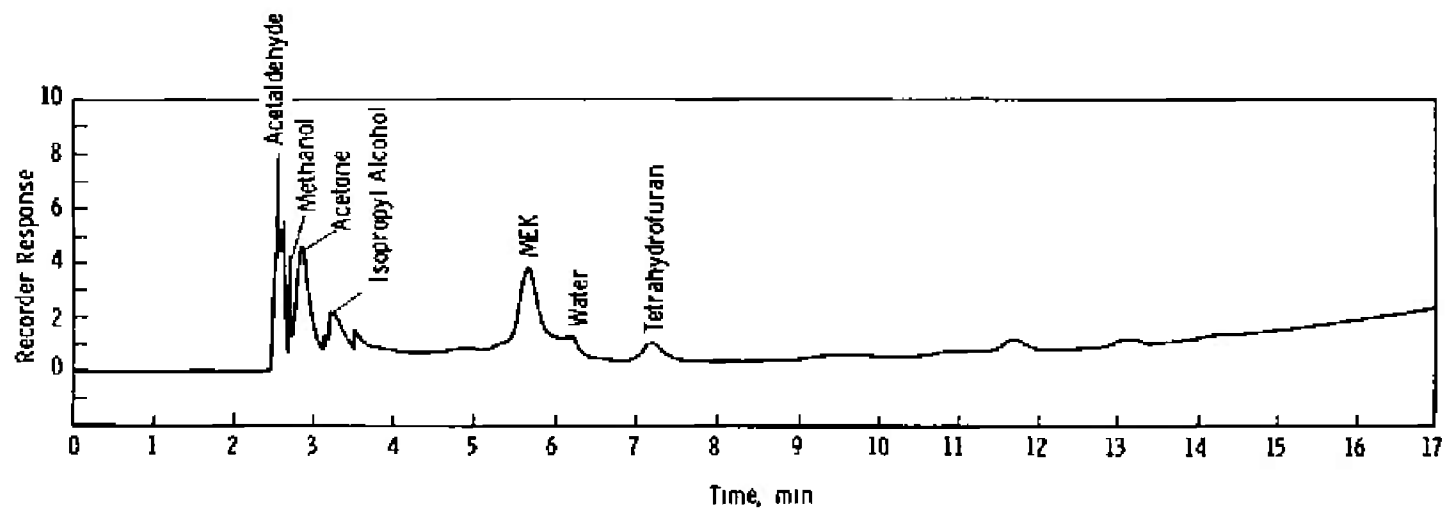


Fig. 16 Chromatogram of Set 19, -175°C (10- $\mu\ell$ Liquid Sample)

TABLE I
STANDARD MIXES

Mix No. 1	Water	Matrix
	Acetone	0.0001 mg/ μ l
	Methyl Alcohol	"
	Ethyl Alcohol	"
	Isopropyl Alcohol	"
	Methyl Ethyl Ketone	"
Mix No. 2	Water	Matrix
	Acetone	0.0001 mg/ μ l
	Acetaldehyde	"
	Diethyl Ether	"
	Methyl Acetate	"
Mix No. 3	Water	Matrix
	Acetone	0.0001 mg/ μ l
	Benzene	"
	Toluene	"
	Xylene	"
Mix No. 4	Acetone	Prepared by taking equal volumes, calculate weight from density, calculate fraction of weight per component in 1 μ l of mix injected.
	Carbon Tetrachloride	
	Pentane	
	Heptane	
	Hexane	
	Tetrachlorethylene	
	1,1 - Dichloroethylene	
	1,1 - Dichloroethane	
	Chloroform	

TABLE II
CHROMATOGRAPH RETENTION-SENSITIVITY DATA

Component	Retention Ratio, Acetone = 1	Sensitivity, mg/div x 10 ⁻³
Methane	0.30	0.00384
Ethylene	0.32	0.0043
Ethane	0.33	0.0073
Propane	0.35	0.0090
Vinyl Chloride	0.55	0.0056
Freon-MF	0.895	Not Calculated Directly
Acetaldehyde	0.907	0.0126
Methanol	0.924	0.00384
Water	0.924	(Small Peak)
Diethyl Ether	0.952 (-)	0.0149
Ethanol	0.952 (+)	0.0109
Acetone	1.00	0.0135
Isopropanol	1.14	0.0151
Pentane	1.16	Not Calculated Directly
Freon-TF	1.21	Not Calculated Directly
1,1-Dichloroethylene	1.22	0.0163
Methylene Chloride	1.27	0.0488
Methyl Acetate	1.27	0.0222
1,1-Dichloroethane	1.65	0.0206
Methyl Ethyl Ketone	1.80	0.0130
Chloroform	2.04	0.0884
Hexane	2.06	0.0031
Tetrahydrofuran	2.18	Not Calculated Directly
Ethylene Dichloride	2.32	0.0364
Benzene	2.65	0.0114
Carbon Tetrachloride	2.76	0.1505
Heptane	3.21	0.0076
Toluene	3.95	0.0132
Tetrachlorethylene	4.51	0.0449
O-Xylene	5.49	0.0184

TABLE III
BENDIX 17-210V MASS SPECTROMETER CALIBRATIONS

Carbon Tetrachloride CCl_4		Propene C_3H_6		Methyl Acetate $\text{CH}_3\text{COOCH}_3$		Ethanol $\text{CH}_3\text{CH}_2\text{OH}$		Normal Pentane $\text{CH}_3(\text{CH}_2)_3\text{CH}_3$		Tetrachloroethylene $\text{CCl}_2=\text{CCl}_2$	
Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr
12	3.86×10^{-5}	1	1.01×10^{-5}	1	6.88×10^{-5}	1	1.84×10^{-5}	1	1.44×10^{-5}	12	2.69×10^{-5}
27	2.03×10^{-5}	2	4.04×10^{-6}	12	5.50×10^{-5}	2	7.45×10^{-6}	14	7.78×10^{-6}	24	4.01×10^{-5}
29	2.03×10^{-5}	13	8.10×10^{-6}	13	3.03×10^{-5}	13	1.19×10^{-5}	15	8.20×10^{-6}	33	1.28×10^{-4}
31	2.03×10^{-5}	14	2.22×10^{-5}	14	1.10×10^{-4}	14	2.52×10^{-5}	28	5.48×10^{-6}	37	3.93×10^{-6}
35	1.83×10^{-4}	15	6.37×10^{-5}	15	6.19×10^{-5}	15	3.19×10^{-5}	27	4.40×10^{-4}	47	1.92×10^{-4}
37	8.16×10^{-5}	16	3.37×10^{-5}	16	5.50×10^{-5}	16	1.19×10^{-5}	28	1.12×10^{-4}	49	8.07×10^{-5}
41	4.06×10^{-5}	19	1.01×10^{-5}	27	5.50×10^{-5}	17	3.49×10^{-5}	30	3.08×10^{-4}	69	9.83×10^{-5}
42	2.03×10^{-5}	19.5	6.07×10^{-6}	28	2.48×10^{-5}	18	1.94×10^{-5}	37	1.16×10^{-5}	81	3.18×10^{-5}
43	1.83×10^{-5}	20	1.02×10^{-5}	29	1.24×10^{-4}	19	4.17×10^{-5}	38	3.31×10^{-5}	82	8.40×10^{-5}
47	1.74×10^{-4}	25	1.13×10^{-5}	30	1.38×10^{-5}	24	7.45×10^{-6}	48	1.75×10^{-4}	83	8.78×10^{-5}
49	5.42×10^{-5}	26	1.01×10^{-4}	31	3.46×10^{-5}	25	2.98×10^{-5}	40	4.03×10^{-5}	84	3.88×10^{-5}
58.5	1.22×10^{-5}	27	4.01×10^{-4}	41	1.79×10^{-5}	26	1.15×10^{-4}	41	5.33×10^{-4}	85	2.31×10^{-5}
59.5	1.32×10^{-5}	28	5.88×10^{-4}	42	1.48×10^{-4}	27	2.71×10^{-4}	42	7.91×10^{-4}	94	1.62×10^{-4}
60.5	4.06×10^{-6}	29	9.22×10^{-4}	43	1.22×10^{-3}	28	7.00×10^{-4}	43	1.27×10^{-3}	95	1.02×10^{-4}
70	4.10×10^{-6}	30	2.53×10^{-3}	44	4.25×10^{-3}	29	2.83×10^{-4}	44	4.47×10^{-3}	98	1.73×10^{-5}
72	4.06×10^{-6}	36	9.10×10^{-6}	45	1.82×10^{-3}	30	7.45×10^{-5}	50	1.01×10^{-5}	119	2.88×10^{-6}
74	8.13×10^{-7}	37	4.04×10^{-5}	46	1.82×10^{-3}	31	1.15×10^{-3}	51	1.15×10^{-5}	121	2.68×10^{-6}
82	1.24×10^{-4}	38	5.07×10^{-5}	59	7.43×10^{-5}	32	1.64×10^{-3}	53	1.44×10^{-5}	129	1.85×10^{-4}
84	8.01×10^{-5}	39	1.82×10^{-4}	74	2.20×10^{-4}	41	1.40×10^{-5}	55	4.18×10^{-6}	131	1.82×10^{-4}
88	1.30×10^{-5}	40	2.73×10^{-5}	75	9.63×10^{-5}	42	4.17×10^{-5}	56	3.46×10^{-5}	133	8.24×10^{-5}
117	3.81×10^{-4}	41	1.76×10^{-4}			43	1.04×10^{-4}	57	1.47×10^{-4}	135	8.67×10^{-5}
119	3.74×10^{-4}	42	5.56×10^{-5}			44	1.49×10^{-5}	58	1.91×10^{-5}	164	8.16×10^{-6}
121	1.20×10^{-4}	43	2.68×10^{-4}			45	4.10×10^{-4}	71	1.10×10^{-3}	166	4.92×10^{-4}
123	1.42×10^{-5}	44	3.04×10^{-4}			46	3.06×10^{-4}	72	1.57×10^{-4}	188	1.92×10^{-4}
		45	1.32×10^{-5}			47	1.19×10^{-5}	73	1.15×10^{-5}	170	4.16×10^{-5}

Hydrogen H_2	
Mass No.	amp/torr
1	3.23×10^{-6}
2	5.14×10^{-4}

Hydrogen Fluoride HF	
Mass No.	amp/torr
19	1.81×10^{-2}
20	1.47×10^{-2}

Ethane C_2H_6	
Mass No.	amp/torr
2	1.22×10^{-5}
12	1.22×10^{-5}
13	1.02×10^{-5}
14	4.31×10^{-5}
15	3.97×10^{-5}
24	1.75×10^{-5}
25	6.36×10^{-5}
26	3.43×10^{-4}
27	4.9×10^{-4}
28	1.49×10^{-3}
29	3.19×10^{-4}
30	4.48×10^{-4}
31	1.75×10^{-3}

Oxygen O_2	
Mass No.	amp/torr
16	8.85×10^{-5}
28	1.77×10^{-5}
32	8.37×10^{-4}

Helium He	
Mass No.	amp/torr
4	1.39×10^{-4}

Carbon Monoxide CO	
Mass No.	amp/torr
12	3.82×10^{-5}
14	5.53×10^{-6}
16	2.44×10^{-5}
28	9.41×10^{-4}
29	1.14×10^{-5}

Water H_2O	
Mass No.	amp/torr
16	2.6×10^{-5}
17	2.03×10^{-4}
18	7.67×10^{-4}
19	2.4×10^{-5}

Methane CH_4	
Mass No.	amp/torr
1	1.27×10^{-5}
12	2.33×10^{-5}
13	6.38×10^{-5}
14	1.38×10^{-4}
15	7.41×10^{-4}
16	9.68×10^{-4}

Argon Ar	
Mass No.	amp/torr
20	9.02×10^{-5}
36	2.0×10^{-5}
40	8.47×10^{-4}

OPERATING PARAMETERS

Pulsed Mode of Operation
 Filament Current 2.5 amps
 Trap Current 30 percent of Full Scale
 Ionizing Potential 70 Electron volts
 Multiplier voltage 1300 volts
 Ion Lens Off
 Scan Rate 4
 Time Constant 0.5 sec

TABLE III (Continued)

m-Xylene $C_8H_{10}(CH_3)_2$		Toluene $C_6H_5CH_3$		Methyl Ethyl Ketone $CH_3COCC_2H_5$		1,1-Dichloroethane CH_3CHCl_2		Isopropyl Alcohol $CH_3CHOHCH_3$		Ethyl Acetate $CH_3COOC_2H_5$	
Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr
1	7.44×10^{-6}	1	1.15×10^{-5}	1	9.07×10^{-6}	1	7.09×10^{-6}	1	9.12×10^{-6}	1	1.43×10^{-5}
14	8.20×10^{-6}	14	1.15×10^{-5}	17	1.43×10^{-5}	12	6.67×10^{-6}	12	9.12×10^{-6}	12	1.43×10^{-5}
15	3.33×10^{-5}	15	2.86×10^{-5}	14	2.44×10^{-5}	13	8.51×10^{-6}	14	4.26×10^{-5}	13	2.72×10^{-5}
26	3.72×10^{-5}	26	4.75×10^{-5}	15	2.20×10^{-4}	14	9.22×10^{-6}	15	1.52×10^{-4}	14	9.60×10^{-5}
27	1.62×10^{-4}	27	9.35×10^{-5}	18	9.07×10^{-6}	16	1.49×10^{-5}	16	7.80×10^{-6}	15	3.19×10^{-4}
28	1.86×10^{-5}	31	1.13×10^{-5}	25	1.45×10^{-6}	24	9.03×10^{-6}	17	7.40×10^{-6}	16	1.18×10^{-5}
29	1.24×10^{-3}	37	5.47×10^{-5}	26	9.44×10^{-5}	26	4.88×10^{-5}	18	7.60×10^{-6}	18	1.81×10^{-5}
30	7.44×10^{-6}	38	9.30×10^{-5}	27	2.74×10^{-4}	27	6.11×10^{-4}	19	6.36×10^{-5}	19	1.43×10^{-5}
37	3.10×10^{-3}	39	3.08×10^{-4}	28	5.44×10^{-5}	28	3.55×10^{-5}	23	7.60×10^{-6}	26	7.43×10^{-5}
38	6.82×10^{-5}	40	4.85×10^{-5}	29	4.17×10^{-4}	33	8.14×10^{-5}	26	3.80×10^{-5}	27	2.19×10^{-4}
39	2.87×10^{-4}	41	3.74×10^{-5}	30	1.07×10^{-5}	36	1.02×10^{-5}	27	2.20×10^{-4}	28	7.43×10^{-5}
40	3.72×10^{-5}	42	5.76×10^{-5}	31	8.07×10^{-6}	37	2.13×10^{-5}	28	1.82×10^{-5}	29	4.35×10^{-4}
41	3.78×10^{-5}	44	1.73×10^{-5}	37	1.81×10^{-5}	47	2.27×10^{-5}	28	1.43×10^{-4}	30	3.44×10^{-5}
43	6.20×10^{-6}	45	7.42×10^{-5}	38	1.81×10^{-5}	48	1.56×10^{-5}	30	1.52×10^{-5}	31	3.80×10^{-5}
50	1.04×10^{-4}	45	5.81×10^{-5}	39	4.72×10^{-5}	49	1.08×10^{-5}	31	7.60×10^{-5}	41	2.38×10^{-5}
51	2.17×10^{-4}	46	4.47×10^{-5}	41	3.98×10^{-5}	50	9.38×10^{-6}	36	3.04×10^{-6}	42	1.39×10^{-4}
52	1.24×10^{-4}	49	2.88×10^{-4}	42	1.09×10^{-4}	61	6.87×10^{-5}	37	2.28×10^{-5}	43	1.75×10^{-3}
53	7.07×10^{-5}	50	1.21×10^{-4}	43	1.82×10^{-3}	62	2.13×10^{-5}	38	3.19×10^{-5}	44	7.24×10^{-5}
54	1.12×10^{-3}	51	1.70×10^{-4}	44	4.54×10^{-5}	62	5.74×10^{-5}	39	9.42×10^{-6}	45	2.41×10^{-5}
55	3.10×10^{-5}	52	5.04×10^{-5}	45	1.81×10^{-5}	64	8.89×10^{-4}	40	1.52×10^{-5}	46	1.81×10^{-6}
62	5.86×10^{-6}	53	2.73×10^{-5}	48	9.07×10^{-6}	65	3.85×10^{-6}	41	1.05×10^{-4}	60	1.61×10^{-5}
63	1.36×10^{-4}	61	4.60×10^{-5}	50	1.81×10^{-5}	65	2.13×10^{-4}	42	8.44×10^{-5}	61	1.64×10^{-4}
64	3.72×10^{-5}	62	8.63×10^{-5}	51	9.07×10^{-6}	65	9.01×10^{-5}	43	2.86×10^{-4}	62	1.45×10^{-6}
65	1.18×10^{-4}	63	1.65×10^{-4}	53	8.07×10^{-6}	68	5.04×10^{-5}	44	1.02×10^{-4}	70	2.28×10^{-5}
66	9.83×10^{-5}	64	3.47×10^{-5}	55	1.09×10^{-5}	68	7.09×10^{-6}	45	1.42×10^{-3}	71	2.17×10^{-5}
74	3.10×10^{-5}	65	1.98×10^{-4}	56	9.07×10^{-6}	68	8.86×10^{-5}	46	4.26×10^{-4}	73	5.62×10^{-5}
76	2.48×10^{-5}	66	4.32×10^{-5}	57	1.12×10^{-4}	100	5.53×10^{-5}	47	7.60×10^{-6}	87	1.81×10^{-5}
78	2.48×10^{-6}	74	2.30×10^{-5}	58	1.09×10^{-5}	102	7.80×10^{-6}	59	5.40×10^{-5}	88	1.63×10^{-4}
77	1.76×10^{-4}	75	1.73×10^{-6}	71	2.36×10^{-5}			60	1.95×10^{-5}		
78	1.05×10^{-4}	77	2.30×10^{-5}	72	2.63×10^{-4}						
79	8.56×10^{-6}	85	1.44×10^{-5}	73	1.63×10^{-5}						
89	3.85×10^{-5}	86	2.01×10^{-5}								
91	1.17×10^{-3}	87	1.44×10^{-5}								
92	1.49×10^{-4}	89	8.33×10^{-5}								
98	7.44×10^{-6}	90	5.76×10^{-5}								
102	2.11×10^{-5}	91	1.30×10^{-3}								
103	7.44×10^{-5}	92	1.31×10^{-3}								
104	6.20×10^{-5}	93	1.15×10^{-4}								
105	3.78×10^{-4}										
106	1.01×10^{-3}										

Carbon Dioxide CO_2		Acetone CH_3COCH_3		Diethyl Ether $C_2H_5OC_2H_5$		Normal Heptane $CH_3(CH_2)_5CH_3$	
Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr
12	5.42×10^{-5}	1	1.03×10^{-5}	1	3.72×10^{-6}	14	8.00×10^{-6}
13	6.75×10^{-7}	12	1.05×10^{-5}	12	1.14×10^{-6}	16	3.40×10^{-6}
14	1.46×10^{-7}	13	3.16×10^{-5}	13	9.15×10^{-6}	26	3.84×10^{-5}
16	1.06×10^{-4}	14	1.14×10^{-4}	14	4.00×10^{-5}	27	4.26×10^{-4}
27	1.76×10^{-5}	15	3.58×10^{-4}	15	1.40×10^{-4}	28	9.9×10^{-5}
28	7.48×10^{-5}	16	1.05×10^{-5}	16	8.68×10^{-6}	29	4.74×10^{-4}
30	2.34×10^{-7}	18	1.05×10^{-5}	19	2.52×10^{-5}	30	1.32×10^{-5}
32	6.50×10^{-7}	24	4.91×10^{-6}	26	6.52×10^{-5}	36	8.00×10^{-6}
44	9.86×10^{-4}	25	2.53×10^{-5}	27	3.50×10^{-4}	39	2.24×10^{-4}
45	1.32×10^{-3}	29	1.20×10^{-4}	28	8.58×10^{-5}	40	4.56×10^{-6}
46	4.94×10^{-6}	27	1.52×10^{-4}	29	6.46×10^{-4}	41	5.46×10^{-4}
		28	3.79×10^{-5}	30	4.00×10^{-5}	42	3.00×10^{-4}
		29	7.37×10^{-5}	31	1.02×10^{-3}	43	1.04×10^{-3}
		36	1.29×10^{-6}	32	1.72×10^{-5}	44	3.04×10^{-3}
		37	4.42×10^{-5}	39	3.72×10^{-6}	50	9.60×10^{-4}
		38	1.63×10^{-5}	41	3.43×10^{-5}	51	1.32×10^{-3}
		39	7.37×10^{-5}	43	2.86×10^{-5}	53	2.4×10^{-8}
		40	1.48×10^{-5}	43	1.03×10^{-4}	55	1.09×10^{-4}
		41	4.21×10^{-5}	44	3.43×10^{-5}	58	3.01×10^{-4}
		42	1.39×10^{-4}	45	3.95×10^{-4}	57	4.70×10^{-4}
		43	1.82×10^{-3}	46	1.26×10^{-5}	68	3.64×10^{-5}
		44	4.63×10^{-5}	59	5.40×10^{-4}	69	1.20×10^{-5}
		57	1.60×10^{-5}	60	2.40×10^{-5}	70	2.13×10^{-4}
		58	4.21×10^{-4}	73	2.97×10^{-5}	71	4.74×10^{-4}
		59	1.68×10^{-5}	74	2.63×10^{-4}	72	4.20×10^{-5}
				75	1.28×10^{-5}	85	2.40×10^{-5}
						100	3.12×10^{-4}

Methanol CH_3OH		Ethylene C_2H_4		Hydrogen Sulfide H_2S	
Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr
1	1.58×10^{-5}	1	6.66×10^{-6}	1	1.21×10^{-5}
2	5.65×10^{-6}	12	1.75×10^{-5}	2	4.85×10^{-8}
12	1.02×10^{-5}	13	2.90×10^{-5}	16	7.28×10^{-6}
13	1.81×10^{-5}	14	5.10×10^{-5}	32	3.26×10^{-4}
14	1.50×10^{-3}	15	1.00×10^{-5}	33	3.20×10^{-4}
15	1.61×10^{-4}	24	7.70×10^{-5}	34	8.12×10^{-4}
16	6.78×10^{-6}	25	1.05×10^{-4}	35	2.30×10^{-5}
17	1.24×10^{-5}	26	5.11×10^{-4}	36	3.64×10^{-5}
18	1.24×10^{-5}	27	5.5×10^{-4}		
28	3.62×10^{-5}	28	2.18×10^{-4}		
29	4.28×10^{-4}	29	3.13×10^{-3}		
30	4.41×10^{-5}				
31	5.12×10^{-4}				
32	3.52×10^{-4}				
33	9.04×10^{-6}				

TABLE III (Concluded)

O-Xylene $C_8H_4(CH_3)_2$		Benzene C_6H_6		Freon 113 CCl_2FCClF_2		Benzene $CH_3(CH_2)_4CH_3$		1,1,1-Trichloro- ethylene CH_2Cl_3		Ethylene Dichloride CH_2ClCH_2Cl	
Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr
1	8.21×10^{-6}	1	6.71×10^{-6}	12	1.38×10^{-5}	1	5.41×10^{-6}	1	7.30×10^{-6}	1	1.0×10^{-5}
16	4.67×10^{-5}	15	1.34×10^{-5}	16	4.24×10^{-6}	14	5.68×10^{-6}	2	1.75×10^{-6}	12	5.91×10^{-6}
26	4.43×10^{-5}	25	9.40×10^{-6}	23	7.63×10^{-6}	15	4.39×10^{-6}	12	3.36×10^{-6}	18	1.04×10^{-5}
27	1.00×10^{-4}	26	4.83×10^{-5}	28	2.12×10^{-5}	26	3.64×10^{-6}	13	4.72×10^{-6}	14	1.82×10^{-5}
28	1.01×10^{-5}	27	4.45×10^{-5}	35	1.65×10^{-4}	27	3.22×10^{-4}	14	2.44×10^{-6}	15	6.36×10^{-6}
29	8.21×10^{-6}	28	8.05×10^{-6}	35	7.24×10^{-5}	28	9.48×10^{-5}	15	1.97×10^{-5}	24	6.16×10^{-6}
37	3.28×10^{-5}	29	5.37×10^{-6}	37	2.20×10^{-5}	29	3.81×10^{-4}	24	1.24×10^{-5}	25	4.00×10^{-5}
39	7.39×10^{-5}	38	1.34×10^{-6}	43	7.63×10^{-6}	30	1.25×10^{-5}	25	3.58×10^{-5}	26	1.65×10^{-4}
40	2.09×10^{-4}	37	6.44×10^{-5}	47	6.91×10^{-6}	37	6.25×10^{-6}	26	1.41×10^{-4}	27	5.38×10^{-4}
43	4.10×10^{-5}	37	5.37×10^{-5}	49	2.75×10^{-5}	38	2.16×10^{-6}	27	9.87×10^{-6}	28	4.50×10^{-5}
41	4.10×10^{-5}	38	8.19×10^{-5}	50	3.22×10^{-5}	39	1.78×10^{-4}	33	7.08×10^{-6}	29	3.64×10^{-6}
50	1.48×10^{-4}	39	1.86×10^{-4}	59	4.24×10^{-6}	40	4.03×10^{-5}	36	2.36×10^{-5}	33	3.82×10^{-5}
51	2.98×10^{-4}	41	1.21×10^{-5}	63	5.51×10^{-6}	41	4.89×10^{-4}	37	2.53×10^{-5}	36	1.96×10^{-5}
52	1.48×10^{-4}	42	6.71×10^{-6}	66	7.71×10^{-5}	42	3.01×10^{-4}	38	1.29×10^{-5}	37	1.45×10^{-5}
53	8.54×10^{-5}	43	1.07×10^{-6}	68	2.42×10^{-5}	43	5.34×10^{-4}	47	2.15×10^{-5}	38	4.09×10^{-6}
61	2.98×10^{-5}	48	6.71×10^{-6}	78	1.02×10^{-5}	44	2.27×10^{-5}	48	6.44×10^{-6}	43	5.00×10^{-6}
62	8.57×10^{-5}	49	4.16×10^{-6}	82	1.78×10^{-5}	50	7.95×10^{-6}	49	9.44×10^{-6}	47	1.73×10^{-5}
63	1.35×10^{-4}	50	2.01×10^{-4}	85	1.57×10^{-5}	51	1.19×10^{-5}	60	3.58×10^{-5}	48	2.25×10^{-5}
64	4.10×10^{-5}	52	2.32×10^{-4}	87	5.08×10^{-6}	52	4.54×10^{-6}	61	2.32×10^{-4}	49	1.09×10^{-4}
65	1.36×10^{-4}	53	1.09×10^{-4}	97	3.39×10^{-6}	53	1.82×10^{-5}	62	4.28×10^{-5}	50	2.08×10^{-5}
66	3.58×10^{-6}	55	1.74×10^{-5}	98	9.32×10^{-6}	54	1.08×10^{-5}	63	7.38×10^{-5}	51	6.04×10^{-5}
74	3.94×10^{-5}	56	8.05×10^{-6}	101	1.89×10^{-4}	55	8.62×10^{-5}	64	8.58×10^{-6}	59	4.34×10^{-6}
75	3.12×10^{-6}	53	9.40×10^{-6}	103	2.58×10^{-4}	56	3.90×10^{-4}	64	9.44×10^{-6}	60	1.95×10^{-5}
76	3.12×10^{-5}	57	5.37×10^{-6}	103	4.32×10^{-6}	57	2.87×10^{-4}	63	4.29×10^{-6}	61	6.45×10^{-5}
77	2.13×10^{-4}	61	1.07×10^{-5}	118	3.73×10^{-5}	58	3.98×10^{-5}	64	5.15×10^{-6}	62	3.87×10^{-4}
78	1.28×10^{-4}	62	1.07×10^{-5}	118	1.69×10^{-5}	58	2.27×10^{-6}	65	8.85×10^{-6}	63	8.77×10^{-5}
79	8.85×10^{-5}	63	4.03×10^{-6}	150	4.24×10^{-6}	67	3.98×10^{-6}	65	8.69×10^{-6}	64	1.27×10^{-4}
80	4.57×10^{-5}	72	1.61×10^{-5}	132	8.47×10^{-6}	68	3.96×10^{-6}	66	1.84×10^{-5}	65	2.78×10^{-4}
91	1.47×10^{-3}	74	4.70×10^{-5}	134	5.08×10^{-6}	69	1.70×10^{-5}	67	1.57×10^{-4}	67	5.00×10^{-6}
92	1.97×10^{-4}	75	2.15×10^{-5}	151	1.91×10^{-4}	70	1.03×10^{-5}	68	2.28×10^{-4}	68	7.09×10^{-5}
102	2.49×10^{-5}	76	1.89×10^{-5}	153	1.23×10^{-4}	71	3.69×10^{-5}	101	3.78×10^{-5}	100	4.54×10^{-6}
103	8.67×10^{-5}	77	1.85×10^{-4}	155	5.30×10^{-5}	72	1.82×10^{-5}	117	9.86×10^{-5}	102	8.16×10^{-6}
104	7.55×10^{-5}	79	1.14×10^{-3}	167	2.97×10^{-6}	73	1.82×10^{-4}	118	3.65×10^{-5}		
105	4.27×10^{-4}	79	6.71×10^{-6}	169	2.97×10^{-6}	87	1.82×10^{-5}	121	1.12×10^{-5}		
106	1.16×10^{-3}										

Methylene Chloride CH_2Cl_2		Chloroform $CHCl_3$		Vinyl Chloride CH_2CHCl		Acet-Aldehyde CH_3CHO		Freon 11 CCl_3F		1,1-Dichloro- ethylene CH_2Cl_2	
Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr	Mass No.	amp/torr
1	1.20×10^{-6}	1	6.17×10^{-6}	1	1.49×10^{-5}	1	1.41×10^{-5}	12	2.80×10^{-5}	1	1.03×10^{-5}
12	1.83×10^{-5}	12	2.47×10^{-5}	2	1.53×10^{-6}	13	1.55×10^{-6}	31	7.92×10^{-6}	12	1.35×10^{-5}
13	3.52×10^{-5}	13	3.56×10^{-6}	12	1.36×10^{-5}	13	3.87×10^{-5}	32	5.21×10^{-6}	13	1.13×10^{-5}
14	4.58×10^{-5}	35	1.29×10^{-4}	13	2.26×10^{-5}	14	1.02×10^{-4}	36	1.22×10^{-4}	14	1.24×10^{-6}
35	9.01×10^{-5}	37	4.26×10^{-5}	14	1.64×10^{-5}	15	2.89×10^{-4}	38	2.60×10^{-5}	20	5.16×10^{-6}
36	1.97×10^{-5}	41	5.56×10^{-6}	19	5.45×10^{-7}	16	4.36×10^{-5}	37	4.06×10^{-5}	24	3.30×10^{-5}
37	3.03×10^{-5}	42	4.84×10^{-6}	24	2.39×10^{-5}	24	1.13×10^{-5}	38	5.73×10^{-6}	25	1.20×10^{-6}
41	2.46×10^{-5}	47	4.45×10^{-4}	25	8.99×10^{-5}	25	3.34×10^{-5}	47	7.50×10^{-5}	28	2.06×10^{-4}
42	1.62×10^{-5}	48	1.03×10^{-4}	26	2.37×10^{-4}	26	4.48×10^{-5}	49	4.50×10^{-5}	27	1.03×10^{-5}
43	5.63×10^{-6}	49	8.45×10^{-6}	27	7.11×10^{-4}	27	4.58×10^{-5}	50	1.04×10^{-5}	35	8.66×10^{-5}
47	1.10×10^{-4}	50	3.15×10^{-5}	35	3.98×10^{-5}	28	2.11×10^{-6}	56	8.75×10^{-5}	37	2.58×10^{-5}
48	6.06×10^{-5}	50	6.17×10^{-6}	37	1.52×10^{-5}	29	2.38×10^{-4}	58	2.76×10^{-5}	47	4.33×10^{-5}
49	5.98×10^{-4}	70	3.71×10^{-5}	47	2.37×10^{-5}	30	1.06×10^{-5}	70	4.69×10^{-6}	48	1.96×10^{-6}
50	3.24×10^{-5}	72	3.71×10^{-5}	48	1.21×10^{-5}	31	7.04×10^{-6}	72	3.12×10^{-6}	49	2.16×10^{-5}
51	1.78×10^{-4}	83	2.92×10^{-4}	49	9.10×10^{-5}	40	7.04×10^{-6}	82	2.03×10^{-5}	50	8.25×10^{-6}
52	5.83×10^{-6}	85	3.45×10^{-4}	50	9.53×10^{-6}	41	2.82×10^{-5}	84	1.35×10^{-5}	58	2.84×10^{-5}
53	1.41×10^{-5}	87	5.80×10^{-5}	50	2.89×10^{-5}	42	7.04×10^{-5}	85	3.64×10^{-6}	59	1.37×10^{-4}
54	2.20×10^{-4}	117	6.17×10^{-6}	61	5.15×10^{-5}	43	1.88×10^{-4}	101	4.52×10^{-4}	60	6.97×10^{-4}
56	1.02×10^{-4}	118	2.16×10^{-5}	62	4.50×10^{-4}	44	3.31×10^{-4}	103	2.81×10^{-4}	61	7.73×10^{-5}
55	3.38×10^{-5}	120	1.98×10^{-6}	64	1.44×10^{-3}	45	2.02×10^{-4}	105	4.90×10^{-6}	62	2.12×10^{-4}
		122	4.17×10^{-6}	65	4.74×10^{-6}	46	7.04×10^{-6}	117	8.90×10^{-6}	66	2.68×10^{-4}
								119	8.85×10^{-6}	68	1.68×10^{-4}
								121	2.60×10^{-6}	100	2.69×10^{-5}

TABLE IV
RATIOS OF PUMPING SPEED TO MOLECULAR LEAK CONDUCTANCE, $K = S_p/C_1$

<u>Compound</u>	<u>Molecular Weight</u>	<u>K</u>
Hydrogen	2.02	9.96×10^3
Helium	4.00	1.07×10^4
Methane	16.0	1.17×10^4
Water	18.0	1.31×10^4
Hydrogen Fluoride	20.0	1.09×10^4
Nitrogen	28.0	9.78×10^3
Carbon Monoxide	28.0	9.97×10^3
Ethylene	28.0	1.00×10^4
Ethane	30.1	1.22×10^4
Oxygen	32.0	8.82×10^3
Methanol	32.0	1.02×10^4
Hydrogen Sulfide	34.0	1.21×10^4
Argon	39.9	1.00×10^4
Carbon Dioxide	44.0	1.17×10^4
Acetaldehyde	44.0	1.06×10^4
Propane	44.1	1.06×10^4
Ethanol	46.1	1.04×10^4
Acetone	58.1	1.48×10^4
Isopropyl Alcohol	60.1	1.06×10^4
Vinyl Chloride	62.5	9.95×10^3
Methyl Ethyl Ketone	72.1	1.05×10^4
Normal Pentane	72.2	1.01×10^4
Diethyl Ether	74.1	1.03×10^4
Methyl Acetate	74.1	1.02×10^4
Benzene	78.1	9.93×10^3
Methylene Chloride	84.9	9.89×10^3
Hexane	86.2	9.93×10^3
Ethyl Acetate	88.1	1.09×10^4
Toluene	92.1	1.21×10^4
1,1 Dichloroethylene	97.0	1.03×10^4
1,1 Dichloroethane	99.0	9.95×10^3
Ethylene Dichloride	99.0	1.00×10^4
Normal Heptane	100.0	1.03×10^4
O-Xylene	106.0	1.64×10^4
M-Xylene	106.0	1.37×10^4
Chloroform	119.0	1.02×10^4
1,1,1 Trichloroethane	133.0	9.86×10^3
Freon 11	137.0	9.64×10^3
Carbon Tetrachloride	154.0	1.02×10^4
Tetrachloroethylene	166.0	1.15×10^4
Freon 113	187.0	1.02×10^4

TABLE V
A TYPICAL MASS SPECTRUM

ECOLOGICAL SAMPLE ANALYSIS TEST — ST0518

SAMPLE SET 85-2-6-14-1BA, 13, TEMP. 78°C.
 LIQUID ☐ MASS OF LIQUID, 0.892 GRAMS.
 VAPOR ☐ VOLUME OF VAPOR, _____ CC AT STP.
 DATE OF MASS SPECTRUM ANALYSIS 6/18/65.
 VOLUME OF SAMPLE BOTTLE, 155.2 CC.
 LEAK FOREPRESSURE, 100 MICRONS.

MASS NO.	PEAK HT.	MASS NO.	PEAK HT.	MASS NO.	PEAK HT.	MASS NO.	PEAK HT.
1	1.9×10^{-10}	35	3.1×10^{-13}	63		93	
2	4.8×10^{-12}	36	5.8×10^{-13}	64		94	2.8×10^{-13}
4		37	2.0×10^{-12}	65		95	
* 2.65		38	3.3×10^{-12}	66		96	
* 2.90		39	5.6×10^{-12}	67		97	
* 3.20		40	4.5×10^{-12}	68		98	
* 3.55		41	1.1×10^{-11}	69		99	
12	1.8×10^{-11}	42	2.4×10^{-11}	70		100	
13	4.9×10^{-12}	43	8.8×10^{-12}	71	5.9×10^{-12}	101	
14	6.6×10^{-12}	44	7.7×10^{-11}	72	5.9×10^{-12}	102	
15	9.5×10^{-12}	45	3.1×10^{-12}	73	4.0×10^{-13}	103	
16	2.0×10^{-10}	46	3.1×10^{-12}	74		105	2.0×10^{-13}
17	1.8×10^{-9}	47	9.0×10^{-13}	75		106	3.2×10^{-13}
18	6.9×10^{-9}	48	4.0×10^{-13}	76		117	
19	1.8×10^{-11}	49	2.7×10^{-13}	77	3.0×10^{-13}	119	
20	1.6×10^{-11}	50	4.9×10^{-13}	78	4.3×10^{-13}	121	
22	3.7×10^{-12}	51	6.8×10^{-13}	79	4.9×10^{-13}	123	
24		52	4.1×10^{-13}	81		129	
25	7.9×10^{-13}	53	4.7×10^{-13}	82	3.2×10^{-13}	131	2.0×10^{-13}
26	5.1×10^{-12}	54	2.3×10^{-13}	83	3.2×10^{-13}	133	
27	8.0×10^{-12}	55	2.6×10^{-13}	84	3.2×10^{-13}	135	
28	2.2×10^{-11}	56	3.2×10^{-13}	85	3.2×10^{-13}	164	
29	3.7×10^{-13}	57	7.0×10^{-13}	86		166	3.2×10^{-13}
30	2.0×10^{-12}	58	3.9×10^{-13}	87	3.0×10^{-13}	168	
31	5.7×10^{-12}	59	2.4×10^{-13}	88		170	
32	5.4×10^{-12}	60		89			
33	3.1×10^{-13}	61		91	3.5×10^{-13}		
34	3.7×10^{-13}	62		92			

* FLIGHT TIMES

TABLE VI
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-3-65		Date Completed	6-5-65	
Sample No	65-2-6-2-2AA		Sample Set	3	
Compound	0°C (mg)		-78°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde	0.0057		0.0056		0.0113
Acetone	0.0668		0.0237		0.0905
Benzene				0.0370	0.0370
Carbon Dioxide	26.80		34.0		216.8
Carbon Tetra- chloride					
Chloroform					
1,1 Dichloro- ethane				0.0033	0.0033
1,1 Dichloro- ethylene					
Diethyl Ether					
Ethane					
Ethanol	0.0021		0.0086		0.0107
Ethylene					
Ethylene Dichlo- ride				0.0065	0.0065
Freon 11				0.6190	0.6190
Heptane					
Hexane				0.0011	0.0011
Hydrogen Fluoride	0.073		0.170		0.243
Hydrogen Sulfide					
Isopropyl Alcohol			0.0142		0.0142
Methane					
Methanol	0.0082		0.0051		0.0133
Methyl Acetate					
Methylene Chloride					
Methyl Ethyl Ketone					
Pentane					
Propane					
Tetrachloroethylene	15.40		29.70		46.45
Toluene				0.1590	0.1590
1,1,1 Trichloro- ethane					
Vinyl Chloride					
Water	550.0		1310.0		1868.0
O-Xylene	1.20			0.1290	1.329
Cylinder Volume	152.3		156.7		156.3

Remarks:

Because of apparatus difficulties the mass spectrometer analyses on the 0°C and -78°C vapors were lost. There was not enough liquid in the -175°C trap for analysis.

TABLE VII
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-4-65		Date Completed	6-6-65	
Sample No	65-2-6-3-2AL		Sample Set	7	
Compound	0°C (mg)		-78°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde	0.0202		0.0105		0.0307
Acetone	0.0026		0.0094		0.0120
Benzene			0.385	0.0020	0.3870
Carbon Dioxide	85.9		58.7	128.7	971.3
Carbon Tetra- chloride					
Chloroform			0.019		0.019
1,1 Dichloro- ethane		0.0021			0.0021
1,1 Dichloro- ethylene				0.0307	0.0307
Diethyl Ether					
Ethane					
Ethanol	0.0016		0.0212		0.0228
Ethylene					
Ethylene Dichlo- ride					
Freon 11					
Heptane			0.790		0.790
Hexane		0.0002		0.0430	0.0432
Hydrogen Fluoride	0.0500		0.226		0.2760
Hydrogen Sulfide					
Isopropyl Alcohol	0.0010		0.0151		0.0161
Methane					
Methanol	0.0049		0.0119		0.0168
Methyl Acetate					
Methylene Chloride					
Methyl Ethyl Ketone					
Pentane					
Propane					
Tetrachloroethylene	13.60		27.50	0.021	41.12
Toluene			0.4520	0.0037	0.4557
1,1,1 Trichloro- ethane					
Vinyl Chloride					
Water	480.0		1390.0	0.100	1870.1
O-Xylene	1.09		2.8	0.022	3.912
Cylinder Volume	155.7		157.2		157.2

Remarks:

Because of apparatus difficulties the 0°C vapor analysis on the mass spectrometer was lost. There was not enough liquid in the -175°C trap for analysis.

TABLE VIII
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-5-65		Date Completed	6-7-65			
Sample No	65-2-6-4-2BA		Sample Set	10			
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde			0.0059				0.0059
Acetone			0.0088	0.0270			0.0358
Benzene		0.0041	0.235			0.0027	0.0303
Carbon Dioxide		4.76	93.2	27.7		2.52	128.2
Carbon Tetra- chloride							
Chloroform						0.0030	0.0030
1,1 Dichloro- ethane		0.0048					0.0048
1,1 Dichloro- ethylene		0.015					0.0150
Diethyl Ether							
Ethane							
Ethanol			0.0049				0.0049
Ethylene							
Ethylene Dichlo- ride							
Freon 11						0.169	0.169
Heptane				0.0180			0.0180
Hexane		0.0307				0.0120	0.0427
Hydrogen Fluoride		0.0003	0.070			0.0006	0.0709
Hydrogen Sulfide		0.023		0.0197		0.0107	0.0534
Isopropyl Alcohol			0.0052				0.0052
Methane							
Methanol			0.0088				0.0088
Methyl Acetate							
Methylene Chloride		0.0056					0.0056
Methyl Ethyl Ketone							
Pentane							
Propane							
Tetrachloroethylene		0.237	6.320	0.18		0.0486	6.786
Toluene						0.0130	0.0130
1,1,1 Trichloro- ethane							
Vinyl Chloride		0.0039					0.0039
Water	60.0	1.286	630.0	0.382		5.510	697.2
O-Xylene		0.026	0.530	0.0308		0.0124	0.5992
Cylinder Volume	158.5		168.5		158.5		

Remarks:

There was not enough liquid in the 0°C or -175°C traps for analysis.

TABLE IX
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-6-65		Date Completed	6-8-65		
Sample No.	65-2-6-5-2AA		Sample Set	16		
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)	Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	
Acetaldehyde	0.0023		0.0181			0.0204
Acetone	0.0002		0.0551		0.0810	0.1363
Benzene					0.0030	0.0030
Carbon Dioxide			63.8	118.0	3.10	184.9
Carbon Tetra- chloride					0.0072	0.0072
Chloroform				0.0075	0.0160	0.0235
1,1 Dichloro- ethane						
1,1 Dichloro- ethylene	0.0004					0.0004
Diethyl Ether						
Ethane					0.0042	0.0042
Ethanol		0.0016	0.0028			0.0044
Ethylene						
Ethylene Dichlo- ride						
Freon 11					0.3970	0.3970
Heptane						
Hexane					0.0343	0.0343
Hydrogen Fluoride			0.089		0.0003	0.0893
Hydrogen Sulfide		0.0057		0.0068		0.0125
Isopropyl Alcohol	0.0009	0.0040	0.0109			0.0158
Methane						
Methanol	0.0451	0.0270	0.0052		0.0250	0.1023
Methyl Acetate						
Methylene Chloride						
Methyl Ethyl Ketone						
Pentane						
Propane		0.0055				0.0055
Tetrachloroethylene		0.039	2.58	0.037	0.0250	2.681
Toluene					0.0240	0.0240
1,1,1 Trichloro- ethane					0.0150	0.0150
Vinyl Chloride					0.0010	0.0010
Water	260.0	0.633	842.0	0.920	5.90	1109
O-Xylene				0.012	0.0120	0.0240
Cylinder Volume	155.5		158.3		156.5	

Remarks.

The 0°C liquid was analyzed by chromatograph only. There was not enough liquid in the -175°C trap for analysis.

TABLE X
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-7-65		Date Completed	6-9-65	
Sample No	65-2-6-6-1BA		Sample Set	18	
Compound	0°C (mg)		-78°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde	0.0004		0.0070		0.0074
Acetone	0.0003	0.007	0.0050		0.0123
Benzene					
Carbon Dioxide	4.50	0.13	31.1	109.0	146.8
Carbon Tetra- chloride					
Chloroform					0.0009
1,1 Dichloro- ethane					0.0046
1,1 Dichloro- ethylene	0.0004		0.0160		0.0164
Diethyl Ether					
Ethane					
Ethanol					
Ethylene					
Ethylene Dichlo- ride					
Freon 11					
Heptane					0.240
Hexane					
Hydrogen Fluoride	0.018		0.103		0.121
Hydrogen Sulfide	0.020	0.0043	0.16	0.018	0.2163
Isopropyl Alcohol	0.0001		0.0197		0.0198
Methane					
Methanol	0.0004		0.0072		0.0076
Methyl Acetate					
Methylene Chloride					
Methyl Ethyl Ketone					
Pentane					
Propane					
Tetrachloroethylene	0.545	0.026	4.19	0.02	4.796
Toluene					0.015
1,1,1 Trichloro- ethane					0.0057
Vinyl Chloride					
Water	150.0	1.09	930.0	1.02	1083
O-Xylene					
Cylinder Volume	158.0		158.7		157.7

Remarks

There was not enough liquid in the -175°C trap for analysis

TABLE XI
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-8-65		Date Completed	6-10-65		
Sample No	65-2-6-7-1BA		Sample Set	22		
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)	Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	
Acetaldehyde			0.0082			0.0082
Acetone			0.0016	0.0300		0.0316
Benzene						
Carbon Dioxide		0.16	125.2	145.3		271.4
Carbon Tetra- chloride						
Chloroform					0.019	0.019
1,1 Dichloro- ethane						
1,1 Dichloro- ethylene						
Diethyl Ether						
Ethane						
Ethanol						
Ethylene						
Ethylene Dichlo- ride						
Freon 11					0.402	0.402
Heptane						
Hexane					0.035	0.035
Hydrogen Fluoride			0.103			0.103
Hydrogen Sulfide		0.015		0.0075	0.0088	0.0313
Isopropyl Alcohol						
Methane						
Methanol			0.0146			0.0146
Methyl Acetate						
Methylene Chloride						
Methyl Ethyl Ketone						
Pentane						
Propane						
Tetrachloroethylene			2.68	0.027	0.053	2.76
Toluene					0.0097	0.0097
1,1,1 Trichloro- ethane						
Vinyl Chloride						
Water	80.0	2.4	770.0	0.27	6.3	859.0
O-Xylene						
Cylinder Volume	158.3		168.5		157.2	
Remarks:						

No chromatograph peaks were detected in the 0°C liquid. There was not enough 0°C or -175°C liquid for mass spectrometer analysis.

TABLE XII
ECOLOGICAL SAMPLE ANALYSIS TEST

ARO Project No. ST0518
Analysis Report

Date Received	6-9-65		Date Completed	6-11-65	
Sample No	65-2-6-8-1BA		Sample Set	26	
Compound	0°C (mg)		-78°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde			0.0038		0.0038
Acetone			0.0178		0.0182
Benzene				0.0004	
Carbon Dioxide		5.66	69.5	34.5	112.8
Carbon Tetra- chloride				0.0199	0.0199
Chloroform					
1,1 Dichloro- ethane				0.0001	0.0001
1,1 Dichloro- ethylene					
Diethyl Ether					
Ethane					
Ethanol			0.0035		0.0038
Ethylene				0.0003	
Ethylene Dichlo- ride				0.0006	0.0006
Freon 11				0.0099	3.28
Heptane					3.290
Hexane				0.0001	0.0001
Hydrogen Fluoride	0.0001		0.147		0.1471
Hydrogen Sulfide	0.010		0.0086		0.0186
Isopropyl Alcohol			0.0212		0.0212
Methane					
Methanol			0.0067		0.0067
Methyl Acetate					
Methylene Chloride					
Methyl Ethyl Ketone					
Pentane					
Propane					
Tetrachloroethylene			2.76	0.016	2.776
Toluene				0.0010	0.0010
1,1,1 Trichloro- ethane					
Vinyl Chloride					
Water	24.0	2.0	1200.0	0.68	1233.0
O-Xylene					
Cylinder Volume	155.4		165.0		154.3

Remarks:

No peaks were detected in the 0°C liquid on the chromatograph. There was not enough liquid in the 0°C and -175°C traps for additional analyses on the mass spectrometer. The Type 1 sample traps were used during the processing of these and all previous samples.

TABLE XIII
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-10-65		Date Completed	6-13-65			
Sample No	65-2-6-9-2AA		Sample Set	31			
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)	Total (mg)	
	Liquid	Vapor	Liquid	Vapor	Liquid		Vapor
Acetaldehyde			0.0121		0.0217	0.0338	
Acetone			0.0010		0.0187	0.0068	0.0265
Benzene					0.0002	0.0002	
Carbon Dioxide		0.07	111.0	31.4		0.910	143.4
Carbon Tetra-chloride						0.0011	0.0011
Chloroform							
1,1 Dichloro-ethane					0.0003		0.0003
1,1 Dichloro-ethylene			0.0156				0.0156
Diethyl Ether							
Ethane							
Ethanol				0.0001	0.0229	0.0048	0.0278
Ethylene							
Ethylene Dichloride					0.0011	0.0071	0.0082
Freon 11				0.017		0.086	0.103
Heptane						0.0001	0.0001
Hexane					0.0001	0.0010	0.0011
Hydrogen Fluoride			0.139				0.1390
Hydrogen Sulfide							
Isopropyl Alcohol			0.1302		0.0149	0.0012	0.1463
Methane							
Methanol			0.0057		0.0160		0.0217
Methyl Acetate							
Methylene Chloride						0.0008	0.0008
Methyl Ethyl Ketone					0.0052		0.0052
Pentane							
Propane							
Tetrachloroethylene			2.04	0.0006		0.0008	2.041
Toluene				0.0003	0.0003	0.0054	0.0060
1,1,1 Trichloro-ethane							
Vinyl Chloride							
Water	12.2	0.12	1066.0	0.026	104.8		1183.0
O-Xylene						0.0002	0.0002
Cylinder Volume	156.5		153.5		156.2		

Remarks

No trace contaminants were detected in the 0°C sample. The quantities of liquid in the 0°C and -175°C samples were too small for analyses on the mass spectrometer. This is the first sample set with which the Type 2 traps were used during the sample processing procedure. The Type 2 traps were used exclusively after this date.

TABLE XIV
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-11-65		Date Completed	6-14-65			
Sample No	65-2-6-10-1BA		Sample Set	34			
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde			0 0160		0 0200		0 0360
Acetone					0 0150	0 0100	0 0250
Benzene						0 0004	0 0004
Carbon Dioxide			120 0	11 0		1 92	132 92
Carbon Tetra- chloride						0 0016	0 0016
Chloroform							
1,1 Dichloro- ethane						0 0031	0 0031
1,1 Dichloro- ethylene							
Diethyl Ether							
Ethane							
Ethanol						0 0060	0 0060
Ethylene							
Ethylene Dichlo- ride					0 0010	0 0100	0 0110
Freon 11						2 30	2 30
Heptane						0 0002	0 0002
Hexane						0 0014	0 0014
Hydrogen Fluoride			0 154				0 154
Hydrogen Sulfide				0 0022			0 0022
Isopropyl Alcohol			0 0210		0 0170	0 0020	0 0400
Methane							
Methanol			0 0010		0 0080		0 0090
Methyl Acetate							
Methylene Chloride						0 0020	0 0020
Methyl Ethyl Ketone					0 0040		0 0040
Pentane							
Propane							
Tetrachloroethylene			1 90			0 0015	1 902
Toluene				0 0010	0 0002	0 0120	0 0132
1,1,1 Trichloro- ethane							
Vinyl Chloride							
Water	6 0		1252.	0 13	81.4		1339 53
O-Xylene						0 0010	0 0010
Cylinder Volume	153 0		151.2		157 8		

Remarks.

No trace contaminants were detected in the 0°C sample. There was not enough liquid in the 0°C trap for analysis on the mass spectrometer.

TABLE XV
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-12-65		Date Completed	6-15-65	
Sample No	65-2-6-11-2BA		Sample Set	3	
Compound	0°C (mg)		-78°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde			0.0227		0.0419
Acetone				0.0210	0.0301
Benzene				0.0004	0.0004
Carbon Dioxide			94.5	4.9	112.40
Carbon Tetra- chloride				0.0016	0.0016
Chloroform					
1,1 Dichloro- ethane				0.0004	0.0004
1,1 Dichloro- ethylene					
Diethyl Ether					
Ethane					
Ethanol			0.0218		0.0282
Ethylene				0.0064	
Ethylene Dichlo- ride				0.0014	0.0104
Freon 11			0.77		2.09
Heptane				0.0001	0.0001
Hexane				0.0009	0.0009
Hydrogen Fluoride			0.102		0.102
Hydrogen Sulfide			0.117		0.117
Isopropyl Alcohol			0.0159		0.0439
Methane				0.0264	0.0016
Methanol			0.0250		0.0459
Methyl Acetate				0.0209	
Methylene Chloride				0.0019	0.0032
Methyl Ethyl Ketone				0.0060	0.0060
Pentane					
Propane					
Tetrachloroethylene					
Toluene				0.0004	0.0083
1,1,1 Trichloro- ethane					
Vinyl Chloride					
Water			645.0	80.0	725.0
O-Xylene				0.0006	0.0006
Cylinder Volume			158.7	158.4	
Remarks					

No analyses were made on the 0°C sample because the valve on the sample bottle was open when the bottle was received from SAM

TABLE XVI
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-13-65		Date Completed	6-16-65			
Sample No	65-2-6-12-2AA		Sample Set	8			
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde			0.0087				
Acetone							
Benzene							
Carbon Dioxide		153.0	91.0	34.5			
Carbon Tetrachloride							
Chloroform							
1,1 Dichloroethane							
1,1 Dichloroethylene							
Diethyl Ether							
Ethane							
Ethanol							
Ethylene							
Ethylene Dichloride							
Freon 11							
Heptane							
Hexane							
Hydrogen Fluoride			0.097				
Hydrogen Sulfide							
Isopropyl Alcohol			0.0137				
Methane							
Methanol			0.0239				
Methyl Acetate							
Methylene Chloride							
Methyl Ethyl Ketone							
Pentane							
Propane							
Tetrachloroethylene							
Toluene				0.0001			
1,1,1 Trichloroethane							
Vinyl Chloride							
Water			789.				
O-Xylene							
Tetrahydrofuran			0.0018				
Cylinder Volume	158.0		157.8		156.9		
Remarks							

The 0°C trap contained only a trace of liquid and not enough for an analysis. No analyses were obtained on the -175°C sample because the glass sample trap fractured after the sample was transferred and while the trap was warming to room temperature.

TABLE XVII
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-14-65		Date Completed	6-17-65			
Sample No	65-2-6-13-2AA		Sample Set	6			
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde			0.0323		0.0394		0.0717
Acetone					0.0227	0.0088	0.0315
Benzene				0.0003		0.0003	0.0006
Carbon Dioxide		3.84	148.0	31.7		5.26	188.80
Carbon Tetrachloride						0.0011	0.0011
Chloroform							
1,1 Dichloroethane					0.0038		0.0038
1,1 Dichloroethylene							
Diethyl Ether							
Ethane							
Ethanol			0.0107			0.0043	0.0150
Ethylene							
Ethylene Dichloride			0.0038		0.0020	0.0045	0.0103
Freon 11						1.17	1.17
Heptane						0.0001	0.0001
Hexane						0.0008	0.0008
Hydrogen Fluoride			0.117				0.117
Hydrogen Sulfide		0.010					0.010
Isopropyl Alcohol			0.0292		0.0263	0.0009	0.0564
Methane							
Methanol			0.0300		0.0029		0.0329
Methyl Acetate							
Methylene Chloride						0.0015	0.0015
Methyl Ethyl Ketone							
Pentane							
Propane							
Tetrachloroethylene		0.0015		0.0005		0.0008	0.0028
Toluene				0.0006	0.0003	0.0004	0.0013
1,1,1 Trichloroethane							
Vinyl Chloride							
Water			958.0		183.0		1141
O-Xylene				0.0002	0.0017	0.0003	0.0022
Tetrahydrofuran						0.0002	0.0002
Cylinder Volume	156.4		157.1		156.3		

Remarks:

The 0°C trap contained only a trace of liquid and not enough for analysis

TABLE XVIII
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-15-65		Date Completed		6-19-65		
Sample No	65-2-6-14-1BA		Sample Set		13		
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde			0 0081		0 0786		0 0867
Acetone			0 0050	0.0006	0.0198	0.0037	0 0291
Benzene						0 0001	0 0001
Carbon Dioxide		0 201	53 6	115		19 8	188 60
Carbon Tetra- chloride			0 0470			0 0070	0.0540
Chloroform							
1,1 Dichloro- ethane			0.0015		0 0004		0.0019
1,1 Dichloro- ethylene							
Diethyl Ether							
Ethane							
Ethanol			0 0126			0 0045	0 0171
Ethylene							
Ethylene Dichlo- ride							
Froon 11				0 037		0 780	0 8170
Heptane					0 0002	0.0005	0.0007
Hexane							
Hydrogen Fluoride			0.115				0.115
Hydrogen Sulfide		0 009	0 093			0 0072	0 1092
Isopropyl Alcohol			0 0545		0 0323	0 0009	0.0877
Methane							
Methanol			0 0126		0.0283		0.0409
Methyl Acetate							
Methylene Chloride			0 0022		0 0026	0.0011	0 0059
Methyl Ethyl Ketone					0 0049		0 0049
Pentane							
Propane							
Tetrachloroethylene							
Toluene						0 0041	0.0041
1,1,1 Trichloro- ethane							
Vinyl Chloride							
Water		0 039	892.		116		1008 039
O-Xylene						0.0003	0.0003
Tetrahydrofuran			0 1800	0.0600	0 4030	0 1280	0 7710
Cylinder Volume	158.1		155.2		157.9		
Remarks							

TABLE XIX
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-16-65		Date Completed	6-19-65			
Sample No	65-2-6-15-2BA		Sample Set	19			
Compound	0°C (mg) Liquid Vapor		-78°C (mg) Liquid Vapor		-175°C (mg) Liquid Vapor		Total (mg)
Acetaldehyde	0.0020		0.0093		0.0262		0.0375
Acetone	0.0082		0.0020		0.0674	0.0284	0.1060
Benzene						0.0009	0.0009
Carbon Dioxide	7.9	0.88	45.6	32.5		365.0	451.88
Carbon Tetra- chloride						0.0058	0.0058
Chloroform							
1,1 Dichloro- ethane						0.0033	0.0033
1,1 Dichloro- ethylene							
Diethyl Ether							
Ethane							
Ethanol						0.0075	0.0075
Ethylene							
Ethylene Dichlo- ride						0.0125	0.0125
Freon 11						1.520	1.520
Heptane						0.0006	0.0006
Hexane						0.0016	0.0016
Hydrogen Fluoride	0.050		0.170				0.220
Hydrogen Sulfide							
Isopropyl Alcohol	0.0004		0.0071		0.0016	0.0884	0.0975
Methane							
Methanol	0.0060		0.0253		0.0170		0.0483
Methyl Acetate							
Methylene Chloride						0.0034	0.0034
Methyl Ethyl Ketone					0.0070		0.0070
Pentane							
Propane							
Tetrachloroethylene			0.0066			0.0055	0.0121
Toluene				0.0002		0.0631	0.0633
1,1,1 Trichloro- ethane							
Vinyl Chloride							
Water	405		1477		190		2072
O-Xylene				0.0001		0.0008	0.0009
Tetrahydrofuran					0.0025		0.0025
Cylinder Volume	158.1		155.2		157.9		
Remarks							

TABLE XX
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-17-65		Date Completed	6-20-65			
Sample No	65-2-6-16-1BA		Sample Set	21			
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde	0.0036		0.0530		0.0157		0.0723
Acetone	0.0021		0.0020		0.0093	0.0116	0.0250
Benzene						0.0009	0.0007
Carbon Dioxide	125.0	0.72	118.4	129.0		369.5	743.
Carbon Tetra- chloride							
Chloroform		0.0025				0.0016	0.0041
1,1 Dichloro- ethane							
1,1 Dichloro- ethylene		0.0001		0.0006			0.0007
Diethyl Ether							
Ethane							
Ethanol					0.0270	0.0035	0.0305
Ethylene							
Ethylene Dichlo- ride						0.0065	0.0065
Freon 11						0.627	0.627
Heptane						0.0003	0.0003
Hexane						0.0013	0.0013
Hydrogen Fluoride	0.112		0.191				0.3030
Hydrogen Sulfide		0.0009				0.0256	0.0265
Isopropyl Alcohol	0.0017		0.0176		0.0152	0.0958	0.1303
Methane							
Methanol	0.0219		0.042		0.0200		0.0461
Methyl Acetate							
Methylene Chloride							
Methyl Ethyl Ketone					0.0007		0.0007
Pentane							
Propane							
Tetrachloroethylene		0.0004				0.0042	0.0046
Toluene						0.0470	0.0470
1,1,1 Trichloro- ethane							
Vinyl Chloride							
Water	962		1550		246		2758.0
O-Xylene						0.0065	0.0065
Tetrahydrofuran					0.0002		0.0002
Cylinder Volume	157.7		167.2		158.5		
Remarks							

TABLE XXI
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-18-65		Date Completed	6-20-65			
Sample No	65-2-6-17-1BA		Sample Set	25			
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde	0.0300		0.0051		0.0105		0.0456
Acetone			0.0051		0.8430	0.0060	0.8541
Benzene							
Carbon Dioxide	28.4	3.76	90.3	46.8		176.0	345.
Carbon Tetra- chloride					0.0099		0.0099
Chloroform						0.0002	0.0002
1,1 Dichloro- ethane					0.0005		0.0005
1,1 Dichloro- ethylene							
Diethyl Ether							
Ethane							
Ethanol	0.0430				0.0155		0.0585
Ethylene							
Ethylene Dichlo- ride						0.0007	0.0007
Freon 11						0.409	0.409
Heptane							
Hexane						0.0005	0.0005
Hydrogen Fluoride	0.098		0.109				0.207
Hydrogen Sulfide		0.0025					0.0025
Isopropyl Alcohol		0.0001	0.0061	0.0005	0.0308	0.0985	0.1360
Methane							
Methanol			0.0384		0.0227		0.0611
Methyl Acetate							
Methylene Chloride							
Methyl Ethyl Ketone					0.0020		0.0020
Pentane							
Propane							
Tetrachloroethylene				0.0005			0.0005
Toluene					0.0003	0.0138	0.0142
1,1,1 Trichloro- ethane							
Vinyl Chloride							
Water	1025		1265		177		2467.0
O-Xylene			0.0030	0.0003			0.0033
Tetrahydrofuran					0.0008		0.0008
Cylinder Volume	157.5		167.7		158.2		
Remarks							

TABLE XXII
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-19-65		Date Completed	6-22-65		
Sample No	65-2-6-18-2AA		Sample Set	30		
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)	Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	
Acetaldehyde	0.0025		0.0036		0.0240	0.0301
Acetone	0.0195		0.4740		0.0130	0.5065
Benzene	0.8110					0.8110
Carbon Dioxide	8.35	0.740	191.4	95.2	418.1	714.
Carbon Tetra- chloride						
Chloroform						
1,1 Dichloro- ethane					0.0024	0.0024
1,1 Dichloro- ethylene						
Diethyl Ether						
Ethane						
Ethanol					0.8360	0.8580
Ethylene					0.0220	
Ethylene Dichlo- ride					0.0525	0.0525
Freon 11	0.640				1.150	1.790
Heptane					0.0001	0.0001
Hexane						
Hydrogen Fluoride	0.083		0.133			0.216
Hydrogen Sulfide			0.1100		0.0310	0.1410
Isopropyl Alcohol	0.0067	0.0001	0.0059	0.0021	0.3428	0.3576
Methane						
Methanol	0.0057		0.0174		0.0166	0.0397
Methyl Acetate						
Methylene Chloride						
Methyl Ethyl Ketone					0.0028	0.0041
Pentane						
Propane						
Tetrachloroethylene						
Toluene					0.0005	0.0402
1,1,1 Trichloro- ethane						
Vinyl Chloride						
Water	723.3		1309		197	2229.3
O-Xylene						
Cylinder Volume	158.1		167.8		157.5	
Remarks						

TABLE XXIII
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-20-65		Date Completed	6-22-65			
Sample No.	65-2-6-19-2BA		Sample Set	33			
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde	0.0036		0.0041		0.0157		0.0234
Acetone	0.4820		0.455		0.0440	0.0377	1.0187
Benzene							
Carbon Dioxide	141.9	7.98	48.7	216.7		1515	1930.
Carbon Tetra- chloride							
Chloroform						150.0	150.0
1,1 Dichloro- ethane					0.0090	0.0192	0.0282
1,1 Dichloro- ethylene							
Diethyl Ether							
Ethane							
Ethanol	0.0012					0.0081	0.0093
Ethylene							
Ethylene Dichlo- ride						0.0136	0.0136
Freon 11						2.92	2.92
Heptane							
Hexane		0.0001		0.0029		0.0052	0.0082
Hydrogen Fluoride	0.1150		0.108				0.2230
Hydrogen Sulfide							
Isopropyl Alcohol		0.0002		0.0013	0.0080	2.3120	2.3215
Methane							
Methanol	0.0073		0.0052		0.0668		0.0793
Methyl Acetate							
Methylene Chloride							
Methyl Ethyl Ketone						0.0050	0.0050
Pentane							
Propane							
Tetrachloroethylene							
Toluene						0.1720	0.1720
1,1,1 Trichloro- ethane							
Vinyl Chloride							
Water	1079		936		253		2268.0
O-Xylene						0.0137	0.0137
Cylinder Volume	158.1		155.0		156.6		

Remarks:

TABLE XXIV
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-21-65		Date Completed	6-23-65		
Sample No	65-2-6-20-2AA		Sample Set	1		
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)	Total (mg)
	Liquid	Vapor	Liquid	Vapor		
Acetaldehyde	0.0196		0.0035		0.0100	0.0331
Acetone	0.0213		0.0403		0.0701	0.1502
Benzene						
Carbon Dioxide	114.0	1.020	93.6	59.7	316.3	585.
Carbon Tetra- chloride						
Chloroform	0.7656	2.227			0.0042	2.9968
1,1 Dichloro- ethane					0.0027	0.0027
1,1 Dichloro- ethylene		0.0003				0.0003
Diethyl Ether						
Ethane						
Ethanol					0.0048	0.0048
Ethylene						
Ethylene Dichlo- ride					0.0032	0.0032
Freon 11					1.327	1.327
Heptane					0.0004	0.0004
Hexane					0.0022	0.0022
Hydrogen Fluoride	0.089		0.126			0.215
Hydrogen Sulfide				0.0050	0.098	0.1030
Isopropyl Alcohol		0.0003	0.0330	0.2670	0.2995	0.5998
Methane						
Methanol	0.0264		0.0122		0.0100	0.0486
Methyl Acetate						
Methylene Chloride						
Methyl Ethyl Ketone					0.0023	0.0023
Pentane						
Propane						
Tetrachloroethylene				0.0006	0.0047	0.0053
Toluene				0.0001	0.1832	0.2067
1,1,1 Trichloro- ethane						
Vinyl Chloride						
Water	781		1280		173.5	2234.
O-Xylene						
Tetrahydrofuran					0.0043	0.0043
Cylinder Volume	157.0		166.5		156.4	
Remarks						

TABLE XXV
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-22-65		Date Completed	6-24-65			
Sample No	65-2-6-21-2AA		Sample Set	5			
Compound	0°C (mg) Liquid Vapor		-78°C (mg) Liquid Vapor		-175°C (mg) Liquid Vapor		Total (mg)
Acetaldehyde	0.0023		0.0044		0.0114		0.0181
Acetone	0.1486		0.0502		0.1240	0.0162	0.3390
Benzene		0.0002					0.0002
Carbon Dioxide	194	3.5	93.6	132		452	875.
Carbon Tetra- chloride						0.0159	0.0159
Chloroform							
1,1 Dichloro- ethane					0.0009		0.0009
1,1 Dichloro- ethylene		0.0005					0.0005
Diethyl Ether							
Ethane							
Ethanol						0.0084	0.0084
Ethylene							
Ethylene Dichlo- ride	0.0030	0.0003				0.0042	0.0075
Freon 11						1.36	1.36
Heptane					0.0001	0.0007	0.0008
Hexane		0.0001				0.0013	0.0014
Hydrogen Fluoride	0.013		0.126				0.139
Hydrogen Sulfide				0.0060			0.0060
Isopropyl Alcohol	0.0019		0.0094	0.0008	0.0093	0.4523	0.4737
Methane							
Methanol	0.0058		0.0216		0.0499		0.0773
Methyl Acetate							
Methylene Chloride	0.0028						0.0028
Methyl Ethyl Ketone					0.0028		0.0028
Pentane							
Propane							
Tetrachloroethylene						0.0022	0.0022
Toluene						0.0192	0.0192
1,1,1 Trichloro- ethane							
Vinyl Chloride							
Water	1027		1240		193.0		2460.0
O-Xylene						0.0035	0.0035
Tetrahydrofuran		<0.0001			0.0043		0.0044
Cylinder Volume	157.4		166.7		156.2		
Remarks							

TABLE XXVI
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-23-65		Date Completed	6-25-65			
Sample No	65-2-6-22-2BA		Sample Set	11			
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde	0.0026		0.0803		0.0164		0.0993
Acetone	2.057		0.0930		0.0382	0.0255	2.2137
Benzene							
Carbon Dioxide	23.9	1.500	211.0	43.0		1158.0	1437.0
Carbon Tetra- chloride							
Chloroform							
1,1 Dichloro- ethane					0.0004		0.0004
1,1 Dichloro- ethylene							
Diethyl Ether							
Ethane							
Ethanol					0.0059		0.0059
Ethylene							
Ethylene Dichlo- ride							
Freon 11						1.310	1.310
Heptane							
Hexane						0.0009	0.0009
Hydrogen Fluoride	0.056		0.177				0.2330
Hydrogen Sulfide							
Isopropyl Alcohol		0.0002		0.0017	0.0082	0.2408	0.2509
Methane							
Methanol	0.0063		0.0851		0.0095		0.1009
Methyl Acetate							
Methylene Chloride							
Methyl Ethyl Ketone					0.0010		0.0010
Pentane							
Propane							
Tetrachloroethylene						0.0112	0.0112
Toluene						0.0659	0.0659
1,1,1 Trichloro- ethane							
Vinyl Chloride							
Water	947.0		1800.0		361.0		3108.0
O-Xylene							
Tetrahydrofuran			0.1290		0.0022		0.131
Cylinder Volume	154.0		159.6		157.9		
Remarks							

TABLE XXVII
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-24-65		Date Completed	6-26-65			
Sample No	65-2-6-23-1BA		Sample Set	13			
Compound	0°C (mg) Liquid Vapor		-78°C (mg) Liquid Vapor		-175°C (mg) Liquid Vapor		Total (mg)
Acetaldehyde	0.0018		0.0054		0.0074		0.0146
Acetone	0.0741		0.3932	0.0004	0.3724	0.0167	0.8568
Benzene					0.0002		0.0002
Carbon Dioxide	77.5	1.30	205.5	101.4		317.0	702.7
Carbon Tetra- chloride							
Chloroform							
1,1 Dichloro- ethane					0.0007	0.0016	0.0023
1,1 Dichloro- ethylene							
Diethyl ether							
Ethane							
Ethanol					0.0004		0.0004
Ethylene							
Ethylene Dichlo- ride			0.0058			0.0028	0.0086
Freon 11						1.108	1.108
Heptane						0.0071	0.0071
Hexane						0.0008	0.0008
Hydrogen Fluoride	0.075		0.212				0.287
Hydrogen Sulfide		0.0058					0.0058
Isopropyl Alcohol		0.0003	0.0048	0.0005		0.2925	0.2981
Methane							
Methanol	0.0074		0.0288		0.0167		0.0529
Methyl Acetate							
Methylene Chloride							
Methyl Ethyl Ketone							
Pentane							
Propane							
Tetrachloroethylene							
Toluene				0.0002		0.0234	0.0236
1,1,1 Trichloro- ethane							
Vinyl Chloride							
Water	614.0		1431.0		172.4	0.600	2218.0
O-Xylene			0.0058				0.0058
Cylinder Volume	154.8		155.9		155.0		
Remarks:							

TABLE XXVIII
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-25-65		Date Completed	6-27-65		
Sample No	65-2-6-24-1BA		Sample Set	17		
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)	Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	
Acetaldehyde			0.0034		0.0128	0.0162
Acetone	0.0087		0.0054		0.1433	0.0297
Benzene		<0.0001				<0.0001
Carbon Dioxide	130.0	1.85	157.0	134.0		434
Carbon Tetra- chloride						
Chloroform						
1,1 Dichloro- ethane					0.0014	0.0014
1,1 Dichloro- ethylene						
Diethyl Ether						
Ethane						
Ethanol	0.0031				0.0013	0.0044
Ethylene		0.0090				0.0090
Ethylene Dichlo- ride						
Freon 11					0.0044	0.0044
Heptane					1.617	1.617
Hexane					0.0004	0.0004
Hydrogen Fluoride	0.098		0.139		0.0013	0.0013
Hydrogen Sulfide						0.0237
Isopropyl Alcohol			0.0066		0.0006	0.4425
Methane					0.4425	0.4497
Methanol	0.0037		0.0135		0.0389	0.0561
Methyl Acetate						
Methylene Chloride						
Methyl Ethyl Ketone					0.0047	0.0047
Pentane						
Propane						
Tetrachloroethylene						
Toluene					0.0131	0.0016
1,1,1 Trichloro- ethane					0.0147	0.0147
Vinyl Chloride						
Water	802	0.780	1220.0		194.	3.32
O-Xylene						2220.
Tetrahydrofuran	0.0021		0.0052		0.0063	0.0140
Cylinder Volume	156.5		168.0		155.7	
Remarks.						

TABLE XXIX
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-26-65		Date Completed	6-29-65			
Sample No	65-2-6-25-2AA		Sample Set	22			
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde	0.0055		0.0082		0.0273		0.0410
Acetone	0.0015		0.0066		0.1177	0.0138	0.1396
Benzene							
Carbon Dioxide	110.0	15.6	160.1	155.4		268.1	709
Carbon Tetra- chloride							
Chloroform							
1,1 Dichloro- ethane					0.0032	0.0009	0.0041
1,1 Dichloro- ethylene							
Diethyl Ether							
Ethane							
Ethanol	0.0101						0.0101
Ethylene		0.0001				0.0014	0.0015
Ethylene Dichlo- ride						0.0010	0.0010
Freon 11						0.660	0.660
Heptane						0.0002	0.0002
Hexane						0.003	0.0003
Hydrogen Fluoride	0.116		0.143				0.259
Hydrogen Sulfide							
Isopropyl Alcohol	0.0013	0.0002		0.0005	0.0051	0.0971	0.1042
Methane							
Methanol	0.0123		0.0106		0.0420		0.0649
Methyl Acetate							
Methylene Chloride							
Methyl Ethyl Ketone					0.0029		0.0029
Pentane							
Propane							
Tetrachloroethylene	0.0084				0.0025	0.0026	0.0125
Toluene	0.0029				0.0081	0.0173	0.0283
1,1,1 Trichloro- ethane							
Vinyl Chloride							
Water	969	0.300	1148	0.140	306		2423
O-Xylene					0.0056		0.0056
Cylinder Volume	156.4		155.0		157.4		
Remarks							

TABLE XXX
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-27-65		Date Completed	6-30-65		
Sample No	65-2-6-26-2BA		Sample Set	27		
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)	Total (mg)
	Liquid	Vapor	Liquid	Vapor		
Acetaldehyde	0.0022		0.0025		0.0096	0.0143
Acetone	0.0016		0.0118		0.0826	0.1098
Benzene						
Carbon Dioxide	34.4	2.11	279	3.77	263.3	582.5
Carbon Tetra- chloride						
Chloroform						
1,1 Dichloro- ethane					0.0015	0.0015
1,1 Dichloro- ethylene						
Diethyl Ether						
Ethane						
Ethanol	0.0064		0.0061			0.0125
Ethylene		<0.0001		<0.0001	0.0002	0.0004
Ethylene Dichlo- ride						
Freon 11					0.83	0.83
Heptane						
Hexane					0.0013	0.0013
Hydrogen Fluoride	0.134		0.150			0.284
Hydrogen Sulfide				0.009		0.009
Isopropyl Alcohol		0.0001	0.0026	0.0001	0.0021	0.0054
Methane					0.0905	0.0905
Methanol	0.0051		0.0043		0.0338	0.0432
Methyl Acetate						
Methylene Chloride						
Methyl Ethyl Ketone					0.0014	0.0014
Pentane						
Propane						
Tetrachloroethylene					0.0032	0.0032
Toluene					0.0167	0.0167
1,1,1 Trichloro- ethane						
Vinyl Chloride						
Water	1177	113	1320			2498
O-Xylene					0.0025	0.0025
Cylinder Volume	157.2		166.8		157.0	
Remarks						

TABLE XXXI
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-28-65		Date Completed	7-1-65			
Sample No	65-2-6-27-2BA		Sample Set	31			
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde	0.0025		0.0046		0.0135		0.0206
Acetone	0.0331		0.0211		0.0997	0.0144	0.1683
Benzene						0.0076	0.0076
Carbon Dioxide	32.2	1.113	138.0	179.0		386.0	736.4
Carbon Tetra- chloride							
Chloroform							
1,1 Dichloro- ethane			0.0027		0.0028		0.0055
1,1 Dichloro- ethylene							
Diethyl Ether							
Ethane							
Ethanol	0.0101						0.0101
Ethylene		0.0001				0.0001	0.0002
Ethylene Dichlo- ride			0.0558		0.0185		0.0743
Freon 1						0.630	0.6300
Heptane							
Hexane						0.0018	0.0018
Hydrogen Fluoride	0.174		0.197				0.3710
Hydrogen Sulfide		0.0100					0.0100
Isopropyl Alcohol		0.0002	0.0049	0.0011	0.0031	0.0258	0.0351
Methane							
Methanol	0.0058		0.0220		0.0414		0.0692
Methyl Acetate							
Methylene Chloride							
Methyl Ethyl Ketone					0.0032		0.0032
Pentane							
Propane							
Tetrachloroethylene						0.0124	0.0124
Toluene						0.0699	0.0699
1,1,1 Trichloro- ethane							
Vinyl Chloride							
Water	1326		1300		172.5		2798.5
O-Xylene						0.0093	0.0093
Cylinder Volume	156.7		153.6		153.8		
Remarks							

TABLE XXXII
ECOLOGICAL SAMPLE ANALYSIS TEST

Date Received	6-29-65		Date Completed	7-2-65			
Sample No	65-2-6-28-1BA		Sample Set	33			
Compound	0°C (mg)		-78°C (mg)		-175°C (mg)		Total (mg)
	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
Acetaldehyde	0.0042	0.0004	0.0035				0.0081
Acetone	0.0097	0.0001	0.0678				0.0776
Benzene							
Carbon Dioxide	19.5	13.4	138	180			350.90
Carbon Tetra- chloride							
Chloroform							
1,1 Dichloro- ethane			0.0040				0.0040
1,1 Dichloro- ethylene							
Diethyl Ether							
Isobutane							
Ethanol	0.0102	0.0002	0.0252				0.0356
Ethylene							
Ethylene Dichlo- ride							
Freon 11							
Heptane							
Hexane							
Hydrogen Fluoride	0.16		0.12				0.28
Hydrogen Sulfide							
Isopropyl Alcohol	0.0008	0.0001	0.0048				0.0057
Methane							
Methanol	0.0050	0.0019	0.0052				0.0121
Methyl Acetate							
Methylene Chloride	0.0047		0.0563				0.0610
Methyl Ethyl Ketone			0.0021				0.0021
Pentane							
Propane							
Tetrachloroethylene							
Toluene			0.0005				0.0005
1,1,1 Trichloro- ethane							
Vinyl Chloride							
Water	1200		1602				2802
O-Xylene							
Cylinder Volume	158.2		154.8				

Remarks

After transfer of the sample the -175°C glass trap fractured while warming to room temperature. The trap contained a very large amount (estimated 3 grams) of CO₂.

TABLE XXXIII
CHROMATOGRAPHIC ANALYSIS REPORT, STANDARD MIX

Sample No.	Standard Mix	Sample Set	Temperature
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[illegible]

Remarks:

The peaks at 0.415, 1.60, and 1.84 are impurities. The peak at 1.27 was calculated as Methylene Chloride. This sample was analyzed on July 2, 1965.

TABLE XXXIV

MASS SPECTROMETER ANALYSIS OF THE STANDARD MIX

ANALYSIS DATE - 7/2/65

STC510 ECOLOGICAL SAMPLE ANALYSIS TEST RUN

0 STANDARD FIX

F. SHERPELL PROGRAM NO. 44011

SET NO. 1

GAS	PI(TORR)	PK	NC. MOLES	PASS NO. (GRAMS)	PASS NO.	W(TAMPS)	H-HICAL.
HELIUM	5.899-06	6.312-02	5.902-04	2.351-03	4	9.200-10	2.000-17
CARBON DIOXIDE	1.816-08	2.127-04	1.989-06	8.752-05	14	1.400-10	1.400-18
HYDROGEN SULFIDE	2.460-09	2.977-05	2.782-07	9.463-06	16	6.000-11	-3.354-12
1,1,1-TRICHLOROETHANE	.000+00	.000+00	.000+00	.000+00	18	5.000-12	2.000-19
O-YLENE	.000+00	.000+00	.000+00	.000+00	20	2.700-12	-3.406-13
TETRACHLOROETHYLENE	.000+00	.000+00	.000+00	.000+00	22	3.200-13	1.000-20
FREON 11	.000+00	.000+00	.000+00	.000+00	26	4.000-12	-2.412-12
1,1-DICHLOROETHYLENE	.000+00	.000+00	.000+00	.000+00	28	1.800-09	1.300-13
TOUENE	4.504-10	5.450-06	5.095-08	4.693-06	30	3.200-12	8.000-19
BENZENE	3.596-09	3.571-05	3.339-07	2.608-05	31	4.600-12	-1.840-12
VINYL CHLORIDE	1.776-05	1.758-05	1.653-07	1.693-05	32	4.300-10	5.000-17
1,1-DICHLOROETHANE	.000+00	.000+00	.000+00	.000+00	34	2.000-12	1.000-19
ETHYLENE DICHLORIDE	7.656-09	7.638-05	7.142-07	7.071-05	39	2.600-12	-3.582-13
NORMAL HEPTANE	1.613-09	1.661-05	1.553-07	1.553-05	40	2.900-11	6.000-18
METHYLENE CHLORIDE	8.105-10	8.019-06	7.698-08	6.356-06	42	4.000-12	-3.221-13
CHLOROFORM	.000+00	.000+00	.000+00	.000+00	43	1.500-11	-1.392-12
CARBON TETRACHLORIDE	.000+00	.000+00	.000+00	.000+00	45	1.500-12	-1.148-12
PROPANE	.000+00	.000+00	.000+00	.000+00	46	2.100-13	-1.789-13
ACETALDEHYDE	.000+00	.000+00	.000+00	.000+00	49	2.100-12	1.000-19
ETHANOL	6.632-10	6.897-06	6.449-06	2.973-06	57	6.400-12	-2.804-15
ACETONE	3.832-09	5.671-05	5.302-07	3.081-05	58	2.000-12	4.000-19
1,3-DICHLOROALCOHOL	.000+00	.000+00	.000+00	.000+00	59	3.000-12	-2.017-14
METHYL ETHYL KETONE	1.468-10	1.562-06	1.461-08	1.053-06	62	3.800-12	-3.282-14
PENTANE	6.565-10	6.635-06	6.205-08	4.479-06	63	5.500-13	-3.925-13
DIETHYL ETHER	5.261-09	5.419-05	5.067-07	3.754-05	64	1.000-12	-2.030-14
METHYL ACETATE	1.077-09	1.099-05	1.027-07	7.612-06	72	2.100-13	1.700-19
HEXANE	7.957-09	7.901-05	7.385-07	6.368-05	74	1.800-12	4.000-19
ETHYLENE	.000+00	.000+00	.000+00	.000+00	78	4.100-12	1.000-19
ETHANE	6.257-05	7.624-05	7.135-07	2.149-05	83	.000+00	-1.143-14
METHANOL	.000+00	.000+00	.000+00	.000+00	92	5.900-13	2.000-20
ARGON	3.371-08	3.371-04	3.152-06	1.258-04	96	.000+00	.000+00
HYDROGEN FLUORIDE	.000+00	.000+00	.000+00	.000+00	97	.000+00	.000+00
OXYGEN	6.736-07	5.941-03	5.555-05	1.778-03	100	8.500-13	3.000-20
WATER	6.500-09	8.515-05	7.962-07	1.433-05	101	.000+00	.000+00
METHANE	.000+00	.000+00	.000+00	.000+00	106	.000+00	.000+00
NITROGEN	1.921-08	1.861-02	1.740-04	4.873-05	117	.000+00	.000+00
CARBON MONOXIDE	5.954-08	5.936-04	5.551-06	1.554-04	166	.000+00	.000+00
1.000-00							

TABLE XXXV
MASS SPECTROMETER DATA ON SAMPLE 65-2-6-5-2AA, 16, 0°C VAPOR

STESIB ECOLOGICAL SAMPLE ANALYSIS TEST RUN
F. SHERRELL PROGRAM NO. 44011

2 2-06-5-2AA, 16 0C 6

SET NO. 7

GAS	P(TORR)	PK	NO. PCLES	PASS (GRAMS)	PASS NO.	H(MPPS)	H-MICAL.)
HELIUM	4.511-05	4.227-03	5.377-03	2.151-02	4	6.270-09	1.000-16
CARBON DIOXIDE	.000+00	.000+00	.000+00	.000+00	14	5.420-11	-2.535-15
HYDROGEN SULFIDE	1.255-05	1.518-05	1.691-07	5.750-06	16	2.290-11	-5.800-12
1,1,1-TRICHLOROETHANE	.000+00	.000+00	.000+00	.000+00	18	1.850-10	3.000-17
O-ZYLENE	3.913-10	6.417-06	7.149-08	7.578-06	20	1.040-12	-8.003-14
TETRACHLOROETHYLENE	1.866-05	2.146-05	2.390-07	3.968-05	22	.000+00	.000+00
FREON 11	.000+00	.000+00	.000+00	.000+00	26	.000+00	-2.062-13
1,1-DICHLOROETHYLENE	.000+00	.000+00	.000+00	.000+00	28	6.350-10	-4.323-11
TOLUENE	.000+00	.000+00	.000+00	.000+00	30	1.300-12	9.054-13
BENZENE	.000+00	.000+00	.000+00	.000+00	31	4.200-12	2.000-19
VINYL CHLORIDE	.000+00	.000+00	.000+00	.000+00	32	1.440-10	4.000-17
1,1-DICHLOROETHANE	.000+00	.000+00	.000+00	.000+00	34	1.020-12	1.000-19
ETHYLENE DICHLORIDE	.000+00	.000+00	.000+00	.000+00	39	4.900-13	7.000-20
NORMAL HEPTANE	.000+00	.000+00	.000+00	.000+00	40	1.050-11	4.000-18
METHYLENE CHLORIDE	.000+00	.000+00	.000+00	.000+00	42	.000+00	-3.292-13
CHLOROFORM	.000+00	.000+00	.000+00	.000+00	43	5.800-13	-2.850-13
CARBON TETRACHLORIDE	.000+00	.000+00	.000+00	.000+00	45	7.800-13	-1.999-13
PROPANE	1.055-05	1.118-05	1.246-07	5.493-06	46	3.300-13	-6.966-15
ACETALDEHYDE	.000+00	.000+00	.000+00	.000+00	49	.000+00	-1.132-13
ETHANOL	3.167-10	3.294-06	3.669-08	1.691-06	57	5.000-13	4.000-20
ACETONE	.000+00	.000+00	.000+00	.000+00	58	.000+00	-2.693-14
ISOPROPYL ALCOHOL	5.635-10	5.973-06	6.654-08	3.599-06	59	.000+00	-2.105-13
METHYL ETHYL KETONE	.000+00	.000+00	.000+00	.000+00	62	.000+00	-2.571-14
PENTANE	.000+00	.000+00	.000+00	.000+00	63	.000+00	-5.283-14
DIETHYL ETHER	.000+00	.000+00	.000+00	.000+00	64	.000+00	-1.604-14
METHYL ACETATE	.000+00	.000+00	.000+00	.000+00	72	.000+00	.000+00
HEXANE	7.269-10	7.218-06	6.041-08	6.932-06	74	.000+00	-1.542-14
ETHYLENE	.000+00	.000+00	.000+00	.000+00	78	.000+00	-5.009-14
ETHANE	.000+00	.000+00	.000+00	.000+00	83	.000+00	-1.078-13
METHANOL	7.408-09	7.556-05	8.412-07	2.694-05	92	.000+00	-7.709-14
ARGON	1.230-06	1.250-04	1.370-06	5.467-05	96	.000+00	-1.903-13
HYDROGEN FLUORIDE	.000+00	.000+00	.000+00	.000+00	97	.000+00	.000+00
OXYGEN	2.527-07	2.729-03	2.483-05	7.946-04	100	.000+00	.000+00
WATER	2.411-07	3.158-03	3.518-05	6.332-04	101	.000+00	.000+00
METHANE	.000+00	.000+00	.000+00	.000+00	106	4.500-13	1.000-20
NITROGEN	7.517-07	7.284-03	8.114-05	2.272-03	117	.000+00	.000+00
CARBON MONOXIDE	.000+00	.000+00	.000+00	.000+00	166	7.500-13	2.000-20
1.000+00							

TABLE XXXVI
MASS SPECTROMETER DATA ON SAMPLE 65-2-6-4-2BA, 10, 0°C VAPOR

ST0510 ECCLOICAL SAMPLE ANALYSIS TEST RUN				1 2-6-04-2BA,10 0C 6			
F. SHERPELL PROGRAM NO. 44011							
SET NO. 7							
GAS	P(TORR)	PK	NO. MOLES	MASS (GRAMS)	MASS NO.	HIAMPS	H-H(CAL.)
HELIUM	4.820-05	5.150-01	5.993-03	2.397-02	4	6.700-09	2.000-16
CARBON DIOXIDE	7.955-07	9.307-03	1.081-04	4.758-03	14	1.510-10	-6.908-14
HYDROGEN SULFIDE	4.920-05	5.952-05	6.918-07	2.352-05	16	2.000-10	-4.406-12
1,1,1-TRICHLOROETHANE	.000+00	.000+00	.000+00	.000+00	18	3.600-10	1.000-17
O-XYLENE	1.304-05	2.129-05	2.426-07	2.635-05	20	5.400-12	6.000-19
TETRACHLOROETHYLENE	1.070-08	1.230-04	1.429-06	2.373-04	22	1.400-11	1.000-18
FREON 11	.000+00	.000+00	.000+00	.000+00	26	7.000-13	-3.584-12
1,1-DICHLOROETHYLENE	1.358-09	1.409-05	1.637-07	1.572-05	28	1.900-09	-1.180-11
TCULENE	.000+00	.000+00	.000+00	.000+00	30	.000+00	-6.988-13
BENZENE	4.676-10	4.643-06	5.395-08	4.214-06	31	.000+00	-1.950-13
VINYL CHLORIDE	5.448-10	5.421-06	6.299-08	3.937-06	32	7.690-10	4.000-17
1,1-DICHLOROETHANE	4.210-10	4.189-06	4.867-08	4.818-06	34	4.000-12	1.000-19
ETHYLENE DICHLORIDE	.000+00	.000+00	.000+00	.000+00	39	1.900-12	-1.077-12
NORMAL HEPTANE	.000+00	.000+00	.000+00	.000+00	40	3.400-11	6.000-16
METHYLENE CHLORIDE	5.834-10	5.770-06	6.705-08	5.692-06	42	1.000-12	-3.550-12
CHLOROPYR	.000+00	.000+00	.000+00	.000+00	43	2.300-11	-5.962-12
CARBON TETRACHLORIDE	.000+00	.000+00	.000+00	.000+00	45	1.400-11	-2.204-12
PROPANE	7.121-09	7.559-05	8.783-07	3.873-05	46	5.500-12	1.344-12
ACETALDEHYDE	2.770-08	2.936-04	3.412-06	1.901-04	49	1.100-12	-1.196-15
ETHANOL	.000+00	.000+00	.000+00	.000+00	57	3.900-12	1.620-12
ACETONE	9.070-09	1.342-04	1.560-06	9.063-05	59	1.900-12	-2.077-12
1,3-DICHLOROETHANE	.000+00	.000+00	.000+00	.000+00	59	1.200-12	-1.747-13
METHYL ETHYL KETONE	.000+00	.000+00	.000+00	.000+00	62	6.500-13	2.000-20
HEPTANE	.000+00	.000+00	.000+00	.000+00	63	3.000-13	4.000-20
DIETHYL ETHER	.000+00	.000+00	.000+00	.000+00	64	.000+00	-7.627-14
METHYL ACETATE	.000+00	.000+00	.000+00	.000+00	72	.000+00	.000+00
HEXANE	3.086-09	3.067-05	3.564-07	3.072-05	74	.000+00	-7.337-14
ETHYLENE	.000+00	.000+00	.000+00	.000+00	78	7.000-13	1.000-20
ETHANE	.000+00	.000+00	.000+00	.000+00	83	1.500-12	8.398-13
METHANOL	.000+00	.000+00	.000+00	.000+00	92	.000+00	-2.570-13
ARGON	3.945-05	3.945-04	4.584-06	1.829-04	96	1.500-12	1.000-19
HYDROGEN FLUORIDE	1.199-10	1.307-06	1.518-08	3.037-07	97	.000+00	.000+00
OXYGEN	1.204-06	1.062-02	1.234-04	3.948-03	100	.000+00	-6.261-14
WATER	4.494-07	6.149-03	7.145-05	1.286-03	101	.000+00	.000+00
METHANE	.000+00	.000+00	.000+00	.000+00	106	1.500-12	1.000-19
NITROGEN	2.040-05	1.476-02	2.297-04	6.431-03	117	.000+00	.000+00
CARBON MONOXIDE	.000+00	.000+00	.000+00	.000+00	166	4.300-12	2.000-19
1.000-00							

TABLE XXXVII
MASS SPECTROMETER RESULTS ON SAMPLE 65-2-6-19-2BA, 33, -175°C VAPOR

STES18 ECOLOGICAL SAMPLE ANALYSIS TEST RUN
P. SHERRELL PROGRAM NC. 44C11

16 2-6-19-2BA, 33 -175C

SET NC.22

GAS	P(TORR)	PK	NO. MOLES	PASS (GRAMS)	PASS NO.	H(AMPS)	H-H(CAL.)
HELIUM	.000+00	.000+00	.000+00	.000+00	4	.000+00	.000+00
CARBON DIOXIDE	7.955-06	9.307-02	3.444-02	1.515+00	14	2.000-11	-1.321-10
HYDROGEN SULFIDE	.000+00	.000+00	.000+00	.000+00	16	9.700-10	3.000-17
1,1,1-TRICHLOROETHANE	.000+00	.000+00	.000+00	.000+00	18	8.000-12	1.000-19
O-ZYLENE	.000+00	.000+00	.000+00	.000+00	20	4.700-13	-1.770-12
TETRACHLOROETHYLENE	.000+00	.000+00	.000+00	.000+00	22	1.400-10	1.000-17
FREON 11	5.973-05	5.756-05	2.131-05	2.919-03	26	5.000-13	-2.650-10
1,1-DICHLOROETHYLENE	.000+00	.000+00	.000+00	.000+00	28	9.700-10	2.000-17
TOUENE	.000+00	.000+00	.000+00	.000+00	30	2.800-12	-3.766-11
BENZENE	.000+00	.000+00	.000+00	.000+00	31	8.000-13	-3.438-10
VINYL CHLORIDE	6.000-07	5.970-03	2.209-03	1.361-01	32	4.100-11	4.000-10
1,1-DICHLOROETHANE	.000+00	.000+00	.000+00	.000+00	34	.000+00	.000+00
ETHYLENE DICHLORIDE	.000+00	.000+00	.000+00	.000+00	39	1.900-12	-4.374-11
NORMAL HEPTANE	.000+00	.000+00	.000+00	.000+00	40	4.200-12	-1.022-11
METHYLENE CHLORIDE	.000+00	.000+00	.000+00	.000+00	42	3.400-12	-1.019-10
CHLOROFORM	1.426-07	1.455-03	5.382-04	6.405-02	43	2.000-10	-2.010-10
CARBON TETRACHLORIDE	.000+00	.000+00	.000+00	.000+00	45	1.200-10	-3.142-10
PROPANE	2.218-07	2.351-03	8.699-04	3.856-02	46	4.800-11	-9.044-11
ACETALDEHYDE	1.016-06	1.079-02	3.994-03	1.757-01	49	1.300-11	-5.392-11
ETHANOL	2.930-07	3.047-03	1.127-03	5.197-02	57	1.200-13	-2.004-11
ACETONE	1.046-06	1.546-05	5.726-06	3.327-04	58	5.000-13	-1.115-12
ISO-PROPYL ALCOHOL	.000+00	.000+00	.000+00	.000+00	59	2.200-13	1.427-13
METHYL ETHYL KETONE	.000+00	.000+00	.000+00	.000+00	62	2.700-13	-2.697-10
PENTANE	.000+00	.000+00	.000+00	.000+00	63	.000+00	-1.794-11
DIETHYL ETHER	.000+00	.000+00	.000+00	.000+00	64	.000+00	-6.640-12
METHYL ACETATE	.000+00	.000+00	.000+00	.000+00	72	7.600-13	-4.550-12
HEXANE	2.953-06	2.932-04	1.085-04	9.251-03	74	.000+00	.000+00
ETHYLENE	.000+00	.000+00	.000+00	.000+00	78	.000+00	.000+00
ETHANE	.000+00	.000+00	.000+00	.000+00	83	8.300-11	3.000-18
METHANOL	.000+00	.000+00	.000+00	.000+00	92	.000+00	.000+00
ARGON	.000+00	.000+00	.000+00	.000+00	96	.000+00	.000+00
HYDROGEN FLUORIDE	.000+00	.000+00	.000+00	.000+00	97	.000+00	.000+00
OXYGEN	4.890-05	4.213-04	1.596-04	5.107-03	100	.000+00	.000+00
WATER	3.019-05	3.952-05	1.464-05	2.634-04	101	2.700-12	1.000-19
METHANE	7.124-06	8.247-04	3.089-04	4.942-03	106	.000+00	.000+00
NITROGEN	.000+00	.000+00	.000+00	.000+00	117	.000+00	-9.591-13
CARBON MONOXIDE	2.114-07	2.107-03	7.797-04	2.183-02	146	.000+00	.000+00
1.000-00							

TABLE XXXVIII
MASS SPECTROMETER RESULTS ON SAMPLE 65-2-6-3-2AL, 7, -78°C LIQUID

AEDC-T-R-66-42

STC518 ECOLOGICAL SAMPLE ANALYSIS TEST RUN
F. SHERRELL PROGRAM NO. 44011

2 2-6-03-2AL,07 -78C L

SET NO. 7

GAS	P(TORR)	PK	NO. MOLES	MASS (GRAMS)	MASS NO.	H(AMPS)	H-H(CAL.)
HELIUM	.000+00	.000+00	.000+00	.000+00	4	.000+00	.000+00
CARBON DIOXIDE	1.477-07	1.728-09	1.334-03	5.871-02	14	1.500-12	5.000-19
HYDROGEN SULFIDE	.000+00	.000+00	.000+00	.000+00	16	1.870-10	-3.858-11
1,1,1-TRICHLOROETHANE	2.241-09	2.210-05	1.706-05	2.289-03	18	6.170-09	3.000-18
O-ZYLENE	7.087-09	3.423-05	2.442-05	2.801-03	20	1.980-11	3.000-18
TETRACHLOROETHYLENE	1.866-08	2.146-04	1.650-04	2.750-02	22	2.600-12	1.000-19
FREON 11	.000+00	.000+00	.000+00	.000+00	26	1.400-12	-1.145-12
1,1-DICHLOROETHYLENE	.000+00	.000+00	.000+00	.000+00	28	2.280-11	1.000-17
TOLUENE	5.255-10	6.363-06	4.912-06	4.524-04	30	9.000-13	5.428-13
BENZENE	6.429-10	6.384-06	4.928-06	2.849-04	31	1.800-12	4.000-19
VINYL CHLORIDE	.000+00	.000+00	.000+00	.000+00	32	2.800-12	3.000-19
1,1,2-DICHLOROETHANE	.000+00	.000+00	.000+00	.000+00	34	.000+00	.000+00
ETHYLENE DICHLORIDE	3.081-09	3.081-05	2.379-05	2.355-03	39	1.840-12	-1.575-12
NORMAL HEPTANE	9.939-10	1.024-05	7.903-06	7.903-04	40	6.300-13	5.000-20
METHYLENE CHLORIDE	.000+00	.000+00	.000+00	.000+00	42	1.500-12	-2.497-12
CHLOROFORM	2.047-11	2.108-07	1.627-07	1.937-05	43	1.670-11	-5.491-12
CARBON TETRACHLORIDE	.000+00	.000+00	.000+00	.000+00	45	6.200-12	-2.292-12
PROPANE	.000+00	.000+00	.000+00	.000+00	46	1.200-12	-1.428-12
ACETALDEHYDE	.000+00	.000+00	.000+00	.000+00	49	5.000-13	-1.218-12
ETHANOL	.000+00	.000+00	.000+00	.000+00	57	1.500-12	-3.953-13
ACETONE	7.316-09	1.083-04	8.359-05	4.856-03	58	2.400-12	-2.390-14
ISOPROPYL ALCOHOL	4.363-09	4.625-05	3.570-05	2.146-03	59	2.100-12	-7.287-14
METHYL ETHYL KETONE	2.499-09	2.624-05	2.020-05	1.461-03	62	7.000-13	-7.780-13
PENTANE	.000+00	.000+00	.000+00	.000+00	63	2.000-13	-6.300-13
DIETHYL ETHER	.000+00	.000+00	.000+00	.000+00	64	5.000-13	-2.440-14
METHYL ACETATE	.000+00	.000+00	.000+00	.000+00	72	4.000-13	-2.997-13
HEXANE	7.000-09	6.551-05	5.366-05	4.625-03	74	.000+00	-1.245-13
ETHYLENE	.000+00	.000+00	.000+00	.000+00	78	1.000-12	1.000-20
ETHANE	.000+00	.000+00	.000+00	.000+00	83	1.100-12	.000+00
METHANOL	2.812-09	2.868-05	2.214-05	7.095-04	92	1.100-12	1.000-19
ARGON	1.349-10	1.269-06	1.041-06	4.154-05	96	1.900-12	-4.422-14
HYDROGEN FLUORIDE	1.346-09	1.467-05	1.133-05	2.265-04	97	8.000-13	3.000-20
OXYGEN	4.268-09	3.762-05	2.904-05	9.294-04	100	4.500-13	1.000-20
WATER	8.044-06	1.054-01	8.135-02	1.464+00	101	.000+00	-6.471-14
METHANE	.000+00	.000+00	.000+00	.000+00	106	2.400-12	1.000-19
NITROGEN	5.358-10	5.190-06	4.007-06	1.122-04	117	.000+00	-8.663-14
CARBON MONOXIDE	1.024-08	1.021-04	7.694-05	2.208-03	166	7.500-12	2.000-19
1.000-00							

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R&D

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13. ABSTRACT A test in which wet air samples were analyzed for trace contaminants was conducted at the Arnold Engineering Development Center for the USAF School of Aerospace Medicine. Sample processing and analysis techniques used during the test are described. The sample processing technique provided a way to transfer the 770K condensables in each sample to a trap of a small volume. This trap was designed to allow removal of small portions of both the sample vapor and the liquid for mass spectrometric and chromatographic analyses. The chromatographic and mass spectrometer instrumentation calibrations, and data reduction procedures are described. The basic test results are presented and discussed. Observations are made concerning the utility of the procedures used.			

air contaminants
trapping
space simulation

[illegible]

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